Utilizing International Students’ Critical Thinking Skill, Disposition, and Perceptions of and in Plant Biotechnology

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Abstract

Of all the areas of agricultural science, plant biotechnology represents one of the most important “specific domains of knowledge” where the teaching of critical thinking skills will have great potential for enhancing the quality of education for students. But although there is significant research on critical thinking and its components as a set of general skills or dispositions, little research exists that has focused on the development of critical thinking within a specific content area, and with respect to exploring potential differences between U.S. and international audiences. Previous research indicates great contrasts between U.S. and European food and agricultural policy, law, culture and society, and historical/ethical perspectives, not only with respect to biotechnology, but also in the public approach to the sciences.

To acquire baseline data on critical thinking dispositions and skills of domestic and international students and explore their perceptions of biotechnology, a descriptive survey utilizing a purposive sample of undergraduate international students (n = 50) and domestic students (n = 27) taking part in a summer aboard program at Universiteit Utrecht was conducted.

Results indicated that domestic students appeared to be more accepting of plant biotechnology than international student respondents, while international students scored significantly lower in the critical thinking dispositions of engagement and innovativeness as well as their overall critical thinking disposition score. These findings suggest that more research is warranted to deeply examine the connection between critical thinking and both domestic and international perceptions of food biotechnology.
Introduction

Critical thinking has been called one of the most important attributes for success in the 21st century (Huitt, 1998). The term has been defined by researchers and theorists as a “set of intellectual standards” that can be used by individuals while thinking (Paul, 1995). The development of critical thinking skills in agricultural audiences has been identified as an especially important need, based on findings which suggest potential deficiencies in terms of our students’ ability to think critically (Rudd, Baker, Hoover & Gregg, 1999).

Of all the areas of agricultural science, plant biotechnology represents one of the most important “specific domains of knowledge” where the teaching of critical thinking skills will have great potential for enhancing the quality of education for students. In fact, perhaps no greater demonstration of the impact and importance of critical thinking exists than in the current debate surrounding the development and production of genetically-engineered crops. Based on the above, in 2000, a USDA Higher Education Challenge grant project was initiated for the purpose of restructuring an undergraduate general education course in the food and agricultural sciences so as to focus on teaching students to think critically within the discipline-specific context of plant biotechnology.

The rationale for this attempt to focus and integrate the teaching of critical thinking within a specific discipline, rather than as a more generalized teaching technique, was based on the work of researchers such as Huitt (1998), who have argued that rather than a set of generalized skills, critical thinking is a process that may best be developed when students learn in connection with a specific domain of knowledge, through which they can come to pursue the thinking and reasoning process to some actionable conclusion or outcome. Although there is significant research on the teaching of critical thinking and its components as a set of skills or standards, few researchers, up to this point, had focused on the development of critical thinking within a specific content area (Carr, 1990; Hichey, 1990; Mertes, 1991).

Based on the above, initial project deliverables included development and testing of six web-based course modules each focusing on one of the six specific critical thinking skills and sub-skills, as identified by Facione (1990), as well as testing and validation of new discipline specific critical thinking disposition and skills instruments. Critical thinking skills assessed in this study included analysis, evaluation, and inference. Facione (1990) described these skills as follows:

ANALYSIS: To identify the intended and actual inferential relationships among statements, questions, concepts, descriptions or other forms of representation intended to express beliefs, judgments, experiences, reasons, information, or opinions.

EVALUATION: To assess the credibility of statements or other representations which are accounts or descriptions of a person's perception, experience, situation, judgment, belief, or opinion; and to assess the logical strength of the actual or intend inferential relationships among statements, descriptions, questions or other forms of representation.

INFERENCE: To identify and secure elements needed to draw reasonable conclusions; to form conjectures and hypotheses; to consider relevant information and to educe the
consequences flowing from data, statements, principles, evidence, judgments, beliefs, opinions, concepts, descriptions, questions, or other forms of representation.

Critical thinking dispositions are attitudinal in nature and developed over time. They are influenced by the environment, social norms, peers, and significant adults. They are “mental habits” that are difficult to change.

The dispositions measured in this study are proposed by Rudd and Irani as a result of their research on critical thinking disposition and in light of Facione’s work (1990). They include Engagement, Cognitive Maturity, and Innovativeness.

**Engagement** is exhibited by an individual who seeks opportunities to reason and exercise their thinking skill. They anticipate situations where they will be required to use reason and plan strategies in advance to solve the anticipated problems or make the required decision. This person is also confident in their ability to reason, solve problems, and make decisions.

People with high **Cognitive Maturity** are aware that most problems are more complex than they appear to be on the surface. They are open to other points of view and even seek them out when making decisions or facing problems. This person is also aware that they bring biases and predispositions to any situation and they make an attempt to keep them “in-check” to clarify their thinking.

**Innovativeness** is displayed when a person spends their time trying to learn more… They are intellectually curious, seeking new knowledge constantly. This person also wants to know the “truth” and is willing to change their position or opinion in light of new information that contradicts prior knowledge.

Based on the above, initial project deliverables included development and testing of six web-based course modules each focusing on one of the six specific critical thinking skills and sub-skills, as identified by Facione (1990), as well as testing and validation of new discipline specific critical thinking disposition and skills instruments. (See Fig. 1).

Fig. 1. Critical thinking project web site.
Although the six course modules are quite comprehensive in covering the science, societal and economic aspects of biotechnology in the US, an international perspective was not initially included in the project. There are, in fact, however, great contrasts between U.S. and European food and agricultural policy, law, culture and society, and historical/ethical perspectives, not only with respect to biotechnology, but also in the public approach to the sciences. Within this context, critical thinking is a key attribute that can be used as a tool to facilitate student understanding and appreciation of the international perspective on science and technology issues in general and biotechnology in particular.

In addition to the need to focus on international aspects of biotechnology, limited research currently exists as to the assessment of critical thinking among international audiences. A second project was therefore initiated to expand and orient toward an international perspective one of the critical thinking skills based course modules, with the goal of enhancing students’ understanding of the values and perceptions held by other societies.

**Purpose and Objectives**

Based on the above, the objectives of this proposed paper are to (1) describe the demographics and perceptions toward plant biotechnology of a purposive sample of Universiteit Utrecht students utilized in the in this new project to provide baseline data; and (2) assess discipline specific critical thinking dispositions and skills of these same students;

**Methods/Results**

To acquire data on critical thinking dispositions and skills, a descriptive survey utilizing a purposive sample of undergraduate international students \( n = 50 \) and domestic students \( n = 27 \) taking part in a summer aboard program at Universiteit Utrecht was conducted. Critical thinking disposition and skills scores were collected using the instruments developed for the original USDA grant project.

The demographic and perceptions instrument was developed by the research team and reviewed by a panel of experts at the University of Florida for content and face validity.

**Findings**

Objective 1: Describe the demographics and perceptions toward plant biotechnology of a purposive sample of Universiteit Utrecht students utilized in the in this new project to provide baseline data.

**Demographics**

Students from the United States represented 35% of the subjects while students from other countries accounted for the balance (65%) of the population studied. The mean age of the domestic students in the study was 20.6 while the mean age of the international students was slightly older, at 23.6. The majority of the international students were female (37) and the minority were male (13). The domestic students were composed of 15 females and one male.
(one student did not report gender). The students represented a wide range of academic majors (29) and countries or origin (20).

Perceptions toward plant biotechnology were measured with a set of questions the students were asked to answer as yes or no. Of the 12 questions asked of the students, the domestic students response was significantly different ($\alpha < .05$) from the international student response in nine of the questions. The responses to the questions can be found in Table 1.

### Table 1

<table>
<thead>
<tr>
<th>Statement of agreement</th>
<th>International mean</th>
<th>Domestic mean</th>
<th>Significance (Wilcox W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you have an adequate understanding of science?</td>
<td>1.56</td>
<td>1.11</td>
<td>.00</td>
</tr>
<tr>
<td>Do you know how food is produced in your country?</td>
<td>1.71</td>
<td>1.33</td>
<td>.00</td>
</tr>
<tr>
<td>Do you know how food is produced in the US?</td>
<td>1.78</td>
<td>1.35</td>
<td>.00</td>
</tr>
<tr>
<td>Have you ever eaten food produced through traditional cross-breeding?</td>
<td>1.40</td>
<td>1.27</td>
<td>.25</td>
</tr>
<tr>
<td>Would you but genetically engineered food if it had health benefits?</td>
<td>1.29</td>
<td>1.04</td>
<td>.01</td>
</tr>
<tr>
<td>Would you buy genetically engineered food if it had environmental benefits?</td>
<td>1.26</td>
<td>1.00</td>
<td>.00</td>
</tr>
<tr>
<td>Would you buy genetically engineered food if it saved you time?</td>
<td>1.68</td>
<td>1.30</td>
<td>.00</td>
</tr>
<tr>
<td>Would you buy genetically engineered food if it saved you money?</td>
<td>1.68</td>
<td>1.26</td>
<td>.00</td>
</tr>
<tr>
<td>Would you eat a potato that had a gene transferred from another plant?</td>
<td>1.49</td>
<td>1.07</td>
<td>.00</td>
</tr>
<tr>
<td>Would you eat a potato that had a gene transferred from a bacterium?</td>
<td>1.85</td>
<td>1.44</td>
<td>.00</td>
</tr>
<tr>
<td>Would you eat a potato that had a gene transferred from an animal?</td>
<td>1.88</td>
<td>1.70</td>
<td>.06</td>
</tr>
<tr>
<td>Would you eat a potato that had a gene transferred from a human?</td>
<td>1.90</td>
<td>1.77</td>
<td>.15</td>
</tr>
</tbody>
</table>

Note. 1 = yes. 2 = no. International $n = 50$. Domestic $n = 27$.

Objective 2: Assess discipline specific critical thinking dispositions and skills of these same students.

Critical thinking dispositions were measured with the EMI scale developed by researchers at the University of Florida. This scale measures disposition to think critically in the three dimensions of Engagement, cognitive Maturity, and Innovativeness. Age had a small ($r = .24$) but insignificant correlation with total EMI score. No significant gender differences were identified in the study group but differences in two of the three constructs and the total EMI...
score were statistically significant when international and domestic students were compared (Table 2).

Table 2
Critical Thinking Disposition Scores of International and Domestic Students

<table>
<thead>
<tr>
<th>Disposition</th>
<th>International mean</th>
<th>Domestic mean</th>
<th>t</th>
<th>df</th>
<th>Significance (two-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engagement</td>
<td>46.4</td>
<td>50.6</td>
<td>3.24</td>
<td>71</td>
<td>.00</td>
</tr>
<tr>
<td>Intellectual Maturity</td>
<td>36.2</td>
<td>37.5</td>
<td>1.11</td>
<td>65</td>
<td>.27</td>
</tr>
<tr>
<td>Innovativeness</td>
<td>31.6</td>
<td>33.6</td>
<td>2.25</td>
<td>69</td>
<td>.03</td>
</tr>
<tr>
<td>Total score</td>
<td>114.0</td>
<td>122.0</td>
<td>2.51</td>
<td>61</td>
<td>.01</td>
</tr>
</tbody>
</table>

Note. International n = 46. Domestic n = 27.

Critical thinking skills were assessed with instrumentation developed by researchers at the University of Florida designed to measure three critical thinking skills (analysis, evaluation, and inference) in the context of plant biotechnology. There was a small (r=.29) but insignificant correlation between age and total critical thinking skills score. International and domestic students differed significantly in their analysis skills but did not show significantly different skill levels in evaluation or inference (Table 3).

Table 3
Critical Thinking Skills Scores of International and Domestic Students

<table>
<thead>
<tr>
<th>Skill</th>
<th>International mean</th>
<th>Domestic mean</th>
<th>T</th>
<th>df</th>
<th>Significance (two-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis</td>
<td>63.1</td>
<td>72.1</td>
<td>3.69</td>
<td>54</td>
<td>.00</td>
</tr>
<tr>
<td>Evaluation</td>
<td>65.9</td>
<td>69.0</td>
<td>1.17</td>
<td>54</td>
<td>.25</td>
</tr>
<tr>
<td>Inference</td>
<td>60.8</td>
<td>65.3</td>
<td>1.88</td>
<td>55</td>
<td>.07</td>
</tr>
<tr>
<td>Total</td>
<td>192.6</td>
<td>206.2</td>
<td>1.96</td>
<td>44</td>
<td>.06</td>
</tr>
</tbody>
</table>


Conclusions and Recommendations

This was a diverse group of students representing 20 different countries and 29 academic majors. The international students and domestic students differed in a variety of ways including their perceptions about biotechnology, critical thinking dispositions, and the critical thinking skill of analysis.

The wide disagreement between the international and domestic students was interesting in that the domestic students appear to be more accepting of plant biotechnology. This is not necessarily a surprise, given the resistance of the European Union and other countries to food biotechnology entering the human food supply. The international students appear to be in line with many international governments in their opposition to food biotechnology. The domestic
students appear to be more accepting of this technology. More research is warranted to deeply examine both domestic and international perceptions of food biotechnology. Specifically, research is needed to examine factors that influence the level of acceptance of food biotechnology both in the United States and abroad.

The international students scored significantly lower in the critical thinking dispositions of engagement and innovativeness as well as the overall critical thinking disposition score. Why does this difference exist? Perhaps the United States encourages this kind of thought in the public schools and universities more than our international neighbors. More research is needed to examine this difference and to confirm or disprove this finding.

There were a number of significant differences on the critical thinking disposition and skill tests. The researchers caution that the results of this study can only be applied to the population studies. Given that, it is important to note that the tests were administered in English and not in the native language of many of the international participants. Although the Universiteit Utrecht students utilized were required to speak English (all courses were taught in English) some certainly had a better command of the language than others. The differences may exist, at least in part, because of a language barrier. The researchers recommend that this study be broadened to include more international students and that the instrumentation be presented to the international students in their native language.

References


