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## **AGRONOMIC EDUCATION AT A CROSSROAD: PROVIDING SKILL SETS OR DEVELOPING MINDSETS?**

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### **Abstract**

Globally, agrifood systems are in constant evolution. In such a context, agronomists have the critical task to act as change agents, enabling agricultural innovation and facilitating the transition towards sustainability. Hence, agronomists should develop a new professional mindset that goes beyond the prescribed roles and fixed duties of a bounded professional. However, it is questionable whether the curricula offered by agronomic education institutes are really targeted at the development of such mindsets. In this study, employing a two-phase mixed research design and drawing on data from 180 agronomy students, we aim at identifying whether the curricula offered to future agronomists by a Greek higher education institute pave the way for the development of new professional mindsets. Our quantitative analysis revealed that agronomy curricula continue to supply students with conventional skill portfolios, and that, to nurture a professional mindset they should focus on the cultivation of soft competencies and the offering of action-based learning opportunities. Qualitative results further support these findings, uncovering that the limited focus paid by curricula to the development of students' soft skills and systemic thinking reduces their feelings of self-efficacy. In parallel, the lack of links connecting academia and agrifood systems generates a sense of isolation from the real agrifood world, which eliminates students' opportunities to test and validate their theoretical knowledge. These findings indicate that agronomy curricula should go beyond the supply of ready-to-use skill sets, by providing students with opportunities to combine theoretical and practical knowledge, and by helping them develop a new professional identity which emphasizes adaptability and cross-boundary thinking.

**Keywords:** agronomic education, skills, competencies, students, agronomists, mindset development

## **Introduction**

Farming systems worldwide are in front of radical changes imposed by the volatile market environments (Marsden et al., 2019), the introduction of smart technologies in farm practice (Miranda et al., 2019), the emergence of new power structures (Rossi et al., 2019), and the challenges posed by climate change (Thornton and Herrero, 2015). Concerns over the future of farming and food systems have led to a growing debate about the need to supply future professionals with skills and competencies needed to help farmers and other agricultural professionals survive in the current, pressing food market, while simultaneously producing high-quality food in high quantities.

Higher education institutes worldwide undertake various attempts to reform their curricula, teaching methods and learning priorities, so as to offer graduates who are expected to work on the agrifood sector key skills and competencies needed to succeed in their professions, as well as to help them develop a professional mindset that will enable them to act as change facilitators. Today, there is general agreement that education on food systems and related fields should move beyond conventional pedagogies, in an attempt to broaden its scope (Hilimire and McLaughlin, 2015), to put emphasis on interdisciplinarity (Bryant et al., 2014), to cultivate sustainability values (Galt et al., 2012), to strengthen students' systems thinking (Hilimire et al., 2014), to take steps that promote collective action and to offer opportunities for critical reflection (Valley et al., 2018) and self-reflection (Anderson, 2013).

Already from the previous century, concerns about the future of the environment led to the incorporation of environmental education (Zoller, 1990; Nash, 1976) and, later, education for sustainability (Cortese, 1999) into the curricula offered by many higher institutions. Recently, new education paradigms – like critical food systems education (Meek and Tarlau, 2016), education for food sovereignty (Mann, 2019) or agroecology education (Lieblein et al., 2012) – which embrace environmental and sustainability-related issues (de Lima Vasconcelos and Silva, 2015), acknowledge the importance of experiential learning for the development of personal and professional agency (Ahmed et al., 2017), and they are concerned about the needs and interests of both learners and the wider agricultural community (Waldenström et al., 2008), have gained considerable momentum in the academic world. In parallel, new methods that go beyond traditional linear knowledge transfer models, involving the development of communities of practice

(Francis et al., 2016), the use of multiple sources of learning instead of the reliance on traditional textbooks (Yamashita and Robinson, 2016), the development of partnerships among universities (Șterbuleac and Toma, 2019) or between universities and actors that participate in the agrifood supply chains (Ahmed et al., 2018; Stewart, 2016) are incorporated in many university programs.

Despite the difficulties associated with epistemological dilemmas (Murakami et al., 2017) and the problems faced due to teachers' personal beliefs, lack of knowledge, and factors associated with the (un)flexibility of the educational system or students' unwillingness to accept changes (Birt et al., 2019), the first outcomes of such initiatives are very encouraging. For instance, Malone et al. (2014) developed and implemented an undergraduate degree program on sustainable food and bioenergy systems at Montana State University, in which they combined traditional classroom and field-based activities, and incorporated both instructional techniques and personal experience projects. The evaluation of the program indicated, among other findings, that students developed a thorough understanding of the sustainability concept and changed their career goals. In another study, Galt et al. (2013) found that a new course (involving methods like field trips and inquiry-based activities) on food systems which they introduced in the curriculum of University of California helped students to enhance their competencies in analyzing food systems and their skills in the inquiry process.

However, as research from different fields indicates, students may hold different perceptions of the competencies they have (Mahachi, 2012) or the skills they need to deploy so as to succeed in the job market (Kamoun-Chouk, 2019). These perceptions can lead to the formation of different assumptions about one's abilities, and consequently to the development of different mindsets that affect not only students' active engagement with their education but also their professional life after graduation. Quite surprisingly, research has not yet thoroughly explored students' perceptions of the competencies they develop during their university education. This study aims at filling this gap, by focusing on agronomy students.

The role of agronomists in the new, continuously changing agrifood context is quite demanding and complex. Although some decades ago agronomists were expected to supply technical guidance to farmers so as to help them improve the efficiency of their enterprises (Bradfield, 1946), today – apart from the offering of agronomic recommendations (Erickson et al., 2018) – they also have to play the role of change agent, facilitating the transition to a sustainable farming future (Charatsari et al., 2018), by collaborating and combining their scientific knowledge with farmers' experiential knowledge (Wright et al., 2016), by engaging in participatory innovation processes

(Lefèvre et al., 2014), and by building partnerships among players involved in the agrifood systems (Hamel and Saindon, 2017).

To effectively perform this role, agronomists must have a broad understanding of the agroecosystem (Ingram and Morris, 2007) and an expanded learning capacity (Charatsari et al., 2018), whereas they also must possess a variety of skills, ranging from traditional technical skills (Gómez et al., 2015), to facilitation, communication and networking competencies (Charatsari and Lioutas, 2019). Hence, agronomists should develop a new professional identity that goes beyond prescribed roles and fixed duties. In other words, they should overcome the role of a “bounded professional” – i.e. a professional who performs specific prescribed roles within the boundaries of a function (Whitchurch, 2008) – and develop a new professional mindset that emphasizes ambidexterity and personal transformation through learning. However, higher agronomic education often prioritizes technical knowledge, without paying equal attention to the development of such skills and competencies (Charatsari et al., 2019).

Hence, a critical question is whether agronomic education is really focused on the development of new mindsets, or, instead, it aims at the transmission of theoretical knowledge and the development of conventional skill portfolios by students. To answer this question, in the present study we examine agronomy students' perceptions of the curricula offered to them by a Greek higher institution. By adopting a user perspective, our focus is on the ability of curricula to equip future agronomists with the skills needed to succeed in the job market and to guide the changes in the agricultural sector, as well as on their contribution to the development of new professional mindsets.

## **Methods**

### ***Participants and procedure***

Participants for this study were 180 students of the Department of Agriculture and the Department of Food Science, International Hellenic University, who voluntarily participated in a workshop about the role of research and education in future agrifood systems, held in March 2018 at their Institute. The mean age of participants was 21.7 years (S.D.=4.09), whereas 52.7% of them were women. Most of the participants studied in the division of plant production (65.6%), whereas 20.6% and 13.9% of them studied in the branches of food science and animal science, respectively. A mixed self-completed questionnaire was given to the participants. After the end of the workshop, completed questionnaires were returned to the research team. The content of the questionnaire is presented in the following section. In a follow-up phase, two focus groups and a series of semi-structured interviews with 10 workshop participants were conducted, so as to collect more detailed data on the issue under study.

## ***Instruments used***

### *Quantitative strand*

Different measures were used to collect data relevant to our research questions. Single items, measured on a five-point scale from “not at all true” to “very true,” were used to assess the degree to which students believe that the curricula offered to agronomy students aim at supplying them with skills needed to compete to current (variable: job-related orientation) and future job market (variable: future orientation), are focused on the development of skills necessary to deal with sustainability challenges (variable: development of sustainability-related skills), and they can help them cultivate a new professional mindset (variable: development of new mindsets).

Another series of single items were added to the questionnaire to capture students’ perceptions of the foci of the curricula they follow. Students were asked to answer the following five items (which endorse the statement “the curriculum in my school...”): “puts emphasis on the agroecosystem components,” “puts emphasis on the theoretical foundations of agronomy,” “prioritizes theory at the expense of practice,” “puts emphasis on the evolution of agricultural science,” and “focuses on the development of soft competencies.” Items were developed after a review of the relevant literature, which points out to the need for curricula to equip students with a deep understanding of the ways agroecosystems operate (Francis et al., 2017b), to emphasize theory but also to offer opportunities for practice-oriented learning (Vietor, 2018; Francis et al., 2017a), to keep up with the changes in the field of agriculture (Podlaski, 2013), and to supply future agronomists with soft skills (Charatsari et al., 2018), we developed five relevant items. In all cases, a scale ranging from 1 (not at all true) to 5 (very true) was used.

Finally, we evaluated students’ perceptions of the need agronomy curricula to focus on the cultivation of four different categories of skills by future agronomists. These categories, depicted in the literature as important for helping agronomists to effectively cope with their work, refer to problem identification/solving skills (Charatsari and Lioutas, 2019), interpersonal competencies (Bard et al., 2019), visioning skills (Francis et al., 2015), and knowledge transfer skills (Śpiewak and Jasiński, 2019). The importance attributed to the cultivation of skills embedding to the three first categories was assessed by using three items for each category. Example items were “a curriculum should help students develop skills in identifying problems of farm enterprises” for problem identification and solving skills, “a curriculum should offer agronomy students opportunities to develop skills in communicating with farmers” for interpersonal skills, and “a curriculum should help students develop skills in setting forth targets for farm enterprises” for visioning skills. Principal axis factor analyses revealed that, as expected,

items load on single factors in all cases (explained variance: 85.89%, 77.67%, 77.31%; Cronbach's alpha: 0.92, 0.86, and 0.85, respectively). Hence, new variables were computed by averaging items. For knowledge transfer skills a single item was used ("a curriculum should provide students with skills of knowledge transfer to farmers"). A scale ranging from 1 (at all) to 5 (very much) was used in all cases.

#### *Qualitative strand*

A series of open-ended questions were used to elicit participants' perceptions of the curriculum they follow, its strengths and weaknesses, as well as its contribution to the development of a professional mindset through the cultivation of new skills and competencies. Moreover, students were asked to list potential topics that should be incorporated into this curriculum. In the follow-up phase (focus groups and semi-structured interviews), more detailed questions on the ability of the degree programs to cultivate a new professional mindset were posed to participants.

#### ***Plan of analysis***

For the quantitative analysis, we employed t-tests and Mann-Whitney tests to examine for differences between variables and between subgroups, respectively. Moreover, a series of multiple regression models were used to examine the relationship of a set of predictors to four different dependent variables (Aiken et al., 2012). The variables referred to the job-market orientation of the curricula, and their contribution to the development of sustainability-related skills and new professional mindsets were used as independent variables. The five variables that assess the foci of the curricula were used as predictors. Beta weights were used to assess the contribution of each independent variable to the model (Nathans et al., 2012).

Qualitative data were thematically analyzed, to identify and organize patterns of meaning (Braun and Clarke, 2012), without relying on implicit theoretical commitments (Braun and Clarke, 2006). After the generation of codes, themes emerged inductively, i.e. without any prior theoretical assumption (Boyatzis, 1998). As suggested by Guest et al. (2011), a process of external review was used to increase the validity of data analysis and interpretation. Qualitative findings were merged with the quantitative results, so as to offer a more complete picture of the issues under study. This process permitted the triangulation of data, thus enhancing the credibility of the research (Nowell et al., 2017).

## **Results**

### ***Quantitative analysis***

The summary statistics for the variables used in the quantitative strand of the analysis are presented in Table 1. As the table illustrates, students' responses stress the need for agronomy curricula to cultivate new skills compared with their current focus on knowledge delivery competencies. Independent sample t-tests showed that knowledge transfer skills received significantly lower mean scores than problem identification and solving skills ( $t=-6.06$ ,  $p<0.001$ ), visioning skills ( $t=-4.05$ ,  $p<0.001$ ) and interpersonal competencies ( $t=-3.57$ ,  $p<0.001$ ).

**Table 1.** Mean scores and standard deviations (S.D.) of study variables

<b>Variable</b>	<b>Mean</b>	<b>S.D.</b>
Skills/competencies needed		
Problem identification and solving skills	3.75	0.96
Interpersonal competencies	3.57	0.97
Visioning skills	3.57	0.86
Knowledge transfer skills	3.37	0.98
Curriculum foci		
Emphasis on agroecosystem components	2.96	0.83
Emphasis on theoretical foundations of agronomy	3.11	0.68
Prioritization of theory at the expense of practice	3.04	1.05
Emphasis on the evolution of agricultural science	2.49	0.87
Focus on the development of soft competencies	2.09	1.05
Curriculum orientation		
Job-related orientation	2.78	0.74
Future orientation	2.76	0.91
Development of sustainability-related skills	2.45	0.86
Development of new mindsets	2.74	1.04

Furthermore, as evidenced by the table, the mean scores for the variables referring to the evaluation of curriculum characteristics are medium to low. Paired sample t-tests revealed that the focus on the development of soft competencies received significantly lower score compared with the other four variables ( $-6.34<t<12.17$ ,  $p<0.01$  in all cases), indicating a limited focus on the cultivation of such competencies. The only difference found among school branches refers to the balance between theory and practice, with students studying animal production to be more critical of the theory/practice ratio than their colleagues from the branch of plant production ( $U=966.0$ ,  $p=0.008$ ). Importantly, the scores on the foci of the curriculum were not found to differ between students who completed their traineeship and those that have not ( $p>0.05$  in all cases).



To examine which of these variables affect students' perception of the orientation of the curriculum we developed two simultaneous regression models (Table 2). In the first model ( $R^2=0.49$ ,  $F=33.06$ ,  $p<0.001$ ) we used as dependent the variable that assessed the job market orientation of the curriculum. The results revealed that the focus on the evolution of agricultural science, the theoretical grounding of agronomy and the emphasis on the development of students' soft skills are positively associated with participants' perception of the fit between the curricula they follow and the job market demands.

**Table 2.** Regressions predicting students' perception of curriculum orientation

Independent variable	Dependent variable			
	Job market orientation		Future orientation	
	$\beta$	p	$\beta$	p
Emphasis on agroecosystem components	0.08	0.164	0.06	0.386
Emphasis on theoretical foundations of agronomy	0.21	0.001	0.13	0.063
Prioritization of theory at the expense of practice	0.02	0.743	-0.07	0.268
Emphasis on the evolution of agricultural science	0.44	0.001	0.26	0.004
Focus on the development of soft competencies	0.21	0.004	0.20	0.019

The second model ( $R^2=0.49$ ,  $F=7.26$ ,  $p<0.001$ ) examined the association of the same variables with the perception that the curriculum can supply students with skills and competencies needed to effectively cope with future professional challenges. Again, we found that soft competencies and the emphasis on the evolution of agricultural science positively predict the dependent variable, whereas the focus on the theoretical foundation of agronomy was marginally non-significant.

The next set of regressions was conducted to examine if and how the different foci of the curricula influence their ability to provide future agronomists with sustainability related skills ( $R^2=0.18$ ,  $F=7.39$ ,  $p<0.001$ ) and to help them cultivate a new professional mindset ( $R^2=0.30$ ,  $F=15.82$ ,  $p<0.001$ ). Using as predictors the same variables (Table 3), we discovered that the emphasis on the development of soft competencies is positively associated with the development of sustainability-related skills. However, a very interesting finding is that prioritization of theory over practice is also positively associated with the cultivation of such skills.

**Table 3.** Regressions predicting students' perception of the association between current curricula and the development of sustainability-related skills and professional mindsets

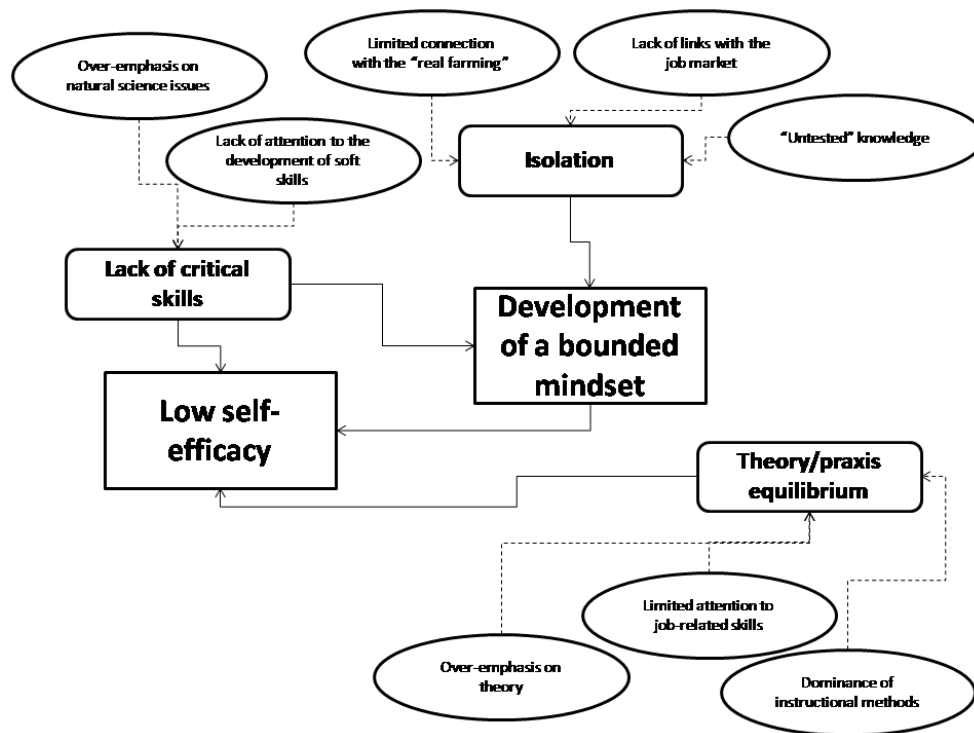
Independent variable	Dependent variable			
	Sustainability skills		Mindset development	
	$\beta$	p	$\beta$	p
Emphasis on agroecosystem components	-0.05	0.450	0.22	0.001
Emphasis on theoretical foundations of agronomy	0.10	0.161	0.03	0.700
Prioritization of theory at the expense of practice	0.14	0.046	-0.15	0.020
Emphasis on the evolution of agricultural science	0.18	0.057	0.26	0.003
Focus on the development of soft competencies	0.23	0.012	0.25	0.003

The second regression model, on the other hand, revealed that overemphasis on theory at the expense of practice negatively affects the development of new mindsets. On the contrary, the emphasis on the recent progress of agricultural science, the prominence given to the understanding of the different agroecosystem components, and the development of soft competencies were all found to be positively associated with the ability of a curriculum to promote a new mindset among future agronomists.

### **Qualitative analysis**

#### *Isolation*

The first theme emerged from our thematic analysis (Figure 1) was labeled “isolation” because it relates to students' sense that the curricula offered create closed systems that supply future agronomists with theoretical knowledge, without however offering opportunities for applying this knowledge in real settings. Some students emphasize the need to have opportunities to test their ability to transfer the knowledge they gain during their studies to farmers. Although most of them agree that the connection between academic institutes and real farm settings is not easy, they stress the importance of communicating with farmers and other actors involved in the agrifood supply chains, to enhance their communication and argumentation competencies, and, on the other hand, to validate their theoretical assumptions.



**Figure 1.** Thematic map emerged from the qualitative analysis

*Theory/praxis equilibrium*

Some participants claim that the concept of “praxis” should be re-approached by the curricula. Most of the interviewees emphasized the need for a shift to hands-off learning styles that go beyond instructional objectives. Among students there is a consensus that the curricula they follow pay limited attention to the practical knowledge, thus not allowing them to develop confidence over their ability to cope with the demands of their future jobs. To date, laboratory exercises are used to enhance students’ practical knowledge. Even though most of the participants acknowledge the value of laboratory work, they feel that laboratory sessions are not enough to help them cultivate skills required by the current and future job market. This sense generates feelings of low self-confidence and limited self-efficacy. As a participant noted: “Students enter the job market without having the necessary skills to cope with real demands of the job.”

*Lack of critical skills*

Most of the students believe that the curricula offer them opportunities to build knowledge on specific – important for the field of agronomy – topics, but without offering the opportunity to develop a new, adaptive mindset, that emphasizes the competency to continuously learn and implement knowledge into different settings and under different

circumstances. To their view, current curricula are not designed to cultivate a new mindset that emphasizes interdisciplinarity, encourages visioning, embraces the challenge of sustainability, and develops future agronomists' systemic thinking.

The skill sets provided during agronomic education are characterized as important and easily applied in well-known problems, but the need to learn how to develop new skills through processes of reflection and personal/professional transformation is emphasized by many students. Moreover, most participants underline the limited attention paid by the curricula they follow to the development of communication and collaboration skills.

According to their responses, a successful professional should be able to build networks and trust-based relationships with farmers and other actors. Since the offering of advisory work is one of the everyday tasks of Greek agronomists, students believe that curricula should pay more attention to the development of consultancy and interpersonal skills. However, today curricula overemphasize natural sciences, without supplying students with such competencies. On the other hand, many students state that current curricula are not ready to face the future challenges of agronomic science. The lack of focus on current "hot" topics, such as the exploitation of smart technologies in the agricultural sector, generates the sense that curricula are somewhat outdated. Such a feeling further reduces students' sense of self-efficacy, generating anxiety about their ability to succeed in the job market.

## **Discussion and conclusions**

This study aimed at examining Greek agronomy students' perceptions of the curricula they follow. Using quantitative and qualitative data derived from a sample of agronomy students of a Greek university, we uncovered that the curricula offered to students are focused on the development of conventional skills, much more than on the nurturing of adaptive professional mindsets. According to the quantitative analysis, the development of such a mindset relies on the ability of a curriculum to follow the evolution of agricultural science, to offer students opportunities to understand the complex nature of the agroecosystem, to supply them with soft competencies, and to provide active learning opportunities.

Importantly, the focus on the development of soft competencies was also found to affect students' perceptions of a curriculum's ability to supplying them with skills needed to succeed in the current and future job market, as well as to develop sustainability-related skills. The qualitative findings support this conclusion, revealing

that the overemphasis on natural science topics and the limited attention paid in soft competencies confine students' feelings of self-efficacy. Since individuals' self-efficacy affects their professional identity (Canrinus et al., 2012), the levels of their occupational stress (Grau et al., 2001), and their intention to engage in different works and tasks (Charatsari et al., 2018), curriculum designers should pay more attention to the cultivation of a sense of mastery among students.

However, the lack of opportunities to actively construct knowledge and to validate this knowledge in real work settings further reduces the feelings of self-efficacy, through the development of a bounded mindset. On the one hand, the limited integration of action learning in the curricula impedes both the development of professional capabilities (Lizzio and Wilson, 2004) and personal abilities to extract knowledge from different work experiences (Lester, 1995). Arguably, the absence of links between academia and actors involved in agrifood production and supply systems does not allow students to test and validate their knowledge in real work settings. Hence, the – based on formal theory – academic knowledge is not merged with the – constructed through practice – professional knowledge; a combination that can set the ground for assessing experience-based knowledge in the light of theory (Even, 1999).

In sum, the present findings point out the need for a shift in the orientation of agronomy curricula. So far, in Greece, the emphasis is put on the development of conventional competencies and ready-to-use skill sets. However, the multiplicity of roles agronomists must play in the current and future agrifood systems generates the need for new competencies, which will lead to the development of a new professional mindset. As the results presented herein indicate, curriculum designers should move beyond traditional views of professional practice, by incorporating in their programs content and practices that can equip future agronomists with the competencies needed to cross professional boundaries and to adapt themselves to the changing needs of their profession.

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