Integrating Artificial Intelligence (AI) Literacy Into Curricula: The Case of Agricultural Sciences at the University of Helsinki

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Abstract
In this study, the concept of AI (artificial intelligence) literacy is evaluated prior to the curriculum planning of the BSc Agricultural Sciences programme. The chosen methodological approach was an integrative literature review, including conceptual structuring of the review, a description of the method, and a review and critical analysis of the literature on AI literacy and its integration in curricula. This process involved synthesising knowledge from literature, AI literacy policies, and practices in the degree programme. In total, 58 literature sources were examined. For BSc Agricultural Sciences students, AI literacy is important in two main areas: agricultural AI applications and the use of AI in studies and research. There is no established definition of AI literacy; a variety of approaches were gathered from the literature. First, AI literacy includes the cognitive elements of both knowledge and skills relating to the content, applications, use, ethics and evaluation of AI, as well as creating with AI. Second, AI literacy contains psychological and metacognitive elements. Additional aspects of AI literacy include targeted learning outcomes, social norms, access to AI tools, critical evaluation and disciplinary knowledge. A visual summary of the literature is presented as an AI literacy framework. Options are proposed for the addition of AI into the constructive alignment table (a leadership spreadsheet tool). The AI literacy framework can be used in developing both the curriculum and the planning tool. We present suggestions to be discussed regarding the inclusion of AI literacy in the forthcoming curriculum of the BSc Agricultural Sciences programme.

Keywords: Artificial Intelligence, AI Literacy, Higher Education, Curriculum, Agricultural Sciences

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1. Introduction

The use of artificial intelligence (AI) is currently a strong trend; one that higher education, like other sectors, needs to respond to (Bearman et al., 2023; Southworth et al., 2023; Essa, 2024). In addition to reading, writing, arithmetic and digital skills, AI literacy is an important skill for both work and everyday life in the 21st century (Ng et al., 2021). Lintner (2024) summarises that 'AI literacy is the ability to understand, interact with, and critically evaluate AI systems and AI outputs.' In this literature survey, the concept of AI literacy is discussed in more detail to help with future curriculum planning in Agricultural Sciences at the University of Helsinki.

According to Yi (2021), the purpose of AI literacy is to have the capability to anticipate an uncertain future. It is important for universities to state clear aims for the use of generative AI (GenAI) and to improve the AI literacy of their students (Song, 2024). In February 2023, the University of Helsinki, Finland, stated that AI is primarily an opportunity and an important work-life skill for students, and that teachers are encouraged to integrate AI teaching into their courses (UH, 2024b, guidelines updated in May 2024). However, teachers may limit or prohibit the use of AI in their courses for pedagogical reasons.

Confidence or self-efficacy (SE) beliefs about learning AI, opinions on the relevance of AI, anxiety towards AI, and AI literacy can all affect students' readiness for learning AI (Dai et al., 2020). The majority of first-year students in Agricultural Sciences (57.6%) viewed the use of AI in studying and research positively, and a quarter of them wanted teaching on the use of AI (Elo et al., 2024). Their readiness and SE belief towards AI was highest for the ethics dimension and lowest for the cognition dimension; the skills and vision dimensions fell in between. Based on that study, AI workshops and lessons have since been arranged for these students. However, there remains a need to discuss the position of AI at the curriculum level as well.

The curricula of the BSc programmes at the University of Helsinki are updated every four years; the next curriculum (for the years 2026–2030) will be drafted in 2025. This survey is driven by the input and needs of various scientific fields, AI development and developers, the workforce, students and active teachers. The aim of this literature survey is to sketch the concept of AI literacy for the purposes of a) developing university teaching in Agricultural Sciences with regard to AI, and b) helping plan the curriculum of the BSc Agricultural Sciences programme. Section 2 presents the methodological approach while Section 3 outlines different approaches to AI literacy. Section 4 includes a visual summary of Section 3 to be considered as a loose AI framework for curriculum planning. The practical aim of this study is to continue the discussion about including AI teaching in the next curriculum for the academic years 2026–2030. This text does not discuss details of e.g., technical content or ethics, but rather sketches a holistic picture of AI literacy. There is literature available on these omitted details; e.g., EU guidelines (EU, 2022) and a review by Ashok, Madan, Joha, and Sivarajah (2022) focusing on ethics.

2. Methodological Approach

The chosen methodological approach was an integrative literature review (Torraco, 2005; Lubbe et al., 2020), including conceptual structuring of the review, a description of the method, and a review and critical analysis of the literature on AI literacy and its integration in curricula. This process involved synthesising knowledge from existing literature, AI literacy

policies, and practices in the Agricultural Sciences degree programme. In total, 58 literature sources were examined.

3. AI Literacy

3.1 Basic Elements and Models of AI Literacy

AI has been defined as 'software that is developed with one or more of the techniques and approaches […] and can, for a given set of human-defined objectives, generate outputs such as content, predictions, recommendations, or decisions influencing the environments it interacts with' (EU, 2022). There is no established definition of AI literacy (Laupichler et al., 2022; Ng et al., 2021; Ng et al., 2023; Walter, 2024), but the basic concept (Lintner, 2024) was presented in Section 1.

AI literacy has its roots in functional, social and technological literacy (Yi, 2021). Functional literacy refers to foundational competences, i.e., the ability to read, write and calculate. Social literacy means understanding texts on a deeper level (critical thinking and social practice), while technological literacy consists of technological intimacy and designing one's social future (Yi, 2021). AI literacy uses the ideas of data science, computational thinking and multi-disciplinary knowledge (Ng et al., 2021). It includes cognitive, metacognitive (knowing what to know), affective (emotions and state of mind) and socio-emotional competencies, which are grounded in universal moral values (Schüller, 2022).

An early concept of AI literacy by Kandlhofer, Steinbauer, Hirschmugl-Gaisch, and Huber (2016) was computer science focused: the topics included problem solving by search, sorting, graphs and data structures. According to Laupichler et al. (2022), Kandlhofer et al. (2016) were the first to coin the term AI literacy in a peer-reviewed article.

A common current concept of AI literacy includes the knowledge and skills to use AI in two main domains (Chan & Hu, 2023; Alamäki et al., 2024; Walter, 2024): first, technology and the working principles of AI; second, the ethical and societal impacts of AI. Zhang et al. (2023) include a third main domain for middle school students to learn about AI, namely career futures in the AI era. The aim of developing AI literacy as a work-life skill was also addressed in the development of curricula at the University of Florida (Southworth et al., 2023). Similar to the University of Helsinki's guidelines (UH, 2024b), Chan and Hu's study in Hong Kong (2023) encouraged higher education institutions to prepare students for a future in which GenAI (generative AI) technologies (UNESCO, 2023) are prevalent.

3.2 Further Developing the Concept of AI Literacy: Disciplinary Knowledge, Taxonomic Levels, Ethics, and Affective and Behavioural Domains

For teaching AI within the discipline of Agricultural Sciences, two types of AI applications should be considered in order to offer students AI work-life skills. The first type is AI applications specifically for studies and research (e.g., the literature reference tool Keenious), and the second is agricultural applications (Table 1). All of these include competence in both the discipline and in AI. Generative AI (GenAI, e.g., ChatGPT) is included in these two main areas.

Table 1: Typical Agricultural Applications of AI (Elo et al., 2024)

Target of use of AI techniques in agriculture	**Reference**
Crop planning and selection	Jha, Doshi, Patel, and Shah (2019); Subeesh and Mehta (2021); Cavazza, Dal Mas, Campra, and Brescia Cavazza (2023)
Yield prediction	Akkem, Biswas, and Varanasi (2023); Ganeshkumar, Jena, Sivakumar, and Nambirajan (2023)
Energy efficiency	Ganeshkumar et al. (2023)
Optimisation of fertiliser and pesticide use	Talaviya, Shah, Patel, Yagnik, and Shah (2020); Subeesh and Mehta (2021); Ganeshkumar et al. (2023); Sachithra and Subhashini (2023)
Water resource management and irrigation	Subeesh and Mehta (2021); Ganeshkumar et al. (2023)
Forecasting of e.g., crop yield production	Akkem et al. (2023); Sachithra and Subhashini (2023)
Greenhouse management	Ganeshkumar et al. (2023)
Automated milking and livestock management	Sachithra and Subhashini (2023)

AI literacy has also been approached from a taxonomic perspective (Krathwohl, 2002). Ng et al. (2021) listed six taxonomic levels of AI literacy (Table 2). Sustainability is a key concept in the curricula at the University of Helsinki (Pietikäinen et al., 2024). At a Finnish university of applied sciences, Alamäki et al. (2024) developed a taxonomy of AI literacy in sustainable development, which includes educational goals integrating the targeted learning outcomes for AI, the discipline (sustainability) and generic work-life skills. Examples of taxonomic learning outcomes relating to sustainability and AI are included in Table 2.

Table 2: Bloom's Taxonomy (Krathwohl, 2002) and AI Literacy (Ng et al. 2021) With Disciplinary Examples (Alamäki et al., 2024)

Taxonomic levels 1–6 (Ng et al., 2021)		**Explanation of learning outcomes (Ng et al., 2021)**	**Examples of learning outcomes for general AI (Ng et al., 2021)**	**Examples of learning outcomes for AI in sustainable development (modified from Alamäki et al., 2024)**
5–6 Evaluate and create AI	6 Create	Produce new or original work	Design, assemble, build and develop AI applications	Can create a concept plan about the ways AI will create value for a specific environmental problem in developing its sustainability
	5 Evaluate	Justify a stand or decision	Appraise, predict, detect and justify decisions with AI applications	Can critically evaluate and justify an AI solution for a specific environmental problem in developing its sustainability
3–4 Use and apply AI	4 Analyse	Draw connections between ideas	Organise, compare, decompose and abstract an AI problem	Can produce a report about the adoption of an AI-based solution that reduces environmental impacts affecting the life of humans in an area
	3 Apply	Use information in new situations	Execute, implement, use and apply AI applications in different contexts	Can use AI-based energy optimiser for a one-family house by selecting, registering, and applying it for a selected case
1–2 Know and understand AI	2 Understand	Explain ideas or concepts	Describe, explain, interpret and demonstrate the meaning of AI	Can describe key principles in using AI for energy savings, such as optimising heating costs based on the weather forecasts
	1 Know	Use information in new situations	Copy, reproduce, recall and memorise AI concepts	Can describe that AI can be used for energy savings and minimising waste

Chiu (2024) underlined that disciplinary knowledge is essential for the appropriate use of GenAI. He recommended that at course level, students should be taught the foundations of their discipline prior to studying with GenAI so that they are able to critically evaluate AI. In a group work scenario, both knowledge of AI and disciplinary knowledge were found to be essential for successful learning (Alamäki et al., 2024). Walter (2024) highlighted the effectiveness of class-wide collaborative prompt engineering sessions, in which students and teachers experiment together with different prompts.

Ng et al. (2021) and Ng et al. (2023) added a fourth cognitive category, AI ethics, which runs parallel to all taxonomic levels. Furthermore, Ng et al. (2023) added affective and behavioural domains to the AI literacy framework. These domains concern key aspects in teaching, for example: are students interested in AI; what are their aims and attitudes

concerning AI; what do they believe they can learn about AI; and what are the individual and collaborative components in learning AI?

In addition to students' ability to use AI related knowledge and skills, Dai et al. (2020) included students' ability to access such knowledge and skills as a component of AI literacy.

3.3 Scales for Measuring Students' AI Literacy

Different scales have been developed for measuring students' AI literacy. Wang et al. (2022) utilised the four basic dimensions described by Ng et al. (2021), Ng et al. (2022), and Ng et al. (2023) to develop an AI literacy scale. In addition to the four categories proposed by Ng et al. (2021), Carolus et al. (2023) added self-management items to their AI literacy scale. The constructs were divided into four groups of psychological competencies: the ability to manage one's own emotions while interacting with AI; the ability to recognise whether one's decisions are influenced by AI, and to stop this influence; the ability to solve problems encountered while working with AI; and the ability to stay up to date with current developments and keep oneself informed about new AI applications (Carolus et al., 2023).

Understanding the limitations of AI and the reasons for AI problems – namely hallucinations, alignment (AI does not necessarily do what we want), self-governance or runaway, discrimination or bias due to the data used in training AI, and getting stuck in a certain narrative (Walter, 2024) – is an essential part of all components of AI literacy. In their definition of AI literacy, Long and Magerko (2020) emphasised critical evaluation and collaborative use of AI as a tool: 'AI literacy is a set of competencies that enables individuals to critically evaluate AI technologies; communicate and collaborate effectively with AI; and use AI as a tool online, at home, and in the workplace'. They divided the core competencies of AI literacy into five main questions: what AI is, what it can do, how it works, how it should be used, and how people perceive it. Based on the study by Long and Magerko (2020), Hornberger, Bewersdorff, and Nerdel (2023) developed an AI literacy test for Germany. UNESCO (2022) also utilised Long and Magerko's (2020) work in an AI literacy competence framework for K-12 education, from kindergarten through to the 12th level. This framework includes elements from Table 1, but in a less concise order. UNESCO (2022) included knowledge, understanding, skills and value orientation in AI literacy: 'AI literacy comprises both data literacy, or the ability to understand how AI collects, cleans, manipulates, and analyses data; and algorithm literacy, or the ability to understand how AI algorithms find patterns and connections in the data, which might be used for human-machine interactions' (UNESCO, 2022). In Finland, AI regulations for K-12 education are currently being prepared (OKM, 2023). AI is mentioned in digital skills for grades 7–9 (OPH, 2022) and programming competences have been defined for K-12 education (EDUFI, 2024).

3.4 Elements of AI Literacy as a Visual Framework for Discussion of AI in the Curriculum

Concerning AI, Ng et al. (2023) describe the aim as providing students with adequate AI literacy. To advance the AI literacy of Agricultural Sciences students, elements of AI literacy from Section 3 have been collected in Figure 1 as a framework for discussion of AI in the curriculum. For this group of students, the term 'discipline' in Figure 1 refers to Agricultural Sciences. Based on the literature, this visual framework presents different aspects that could be discussed when planning AI teaching in higher education. The definitions, relations and

causality of the items in the framework vary across the theoretical models found in the literature.

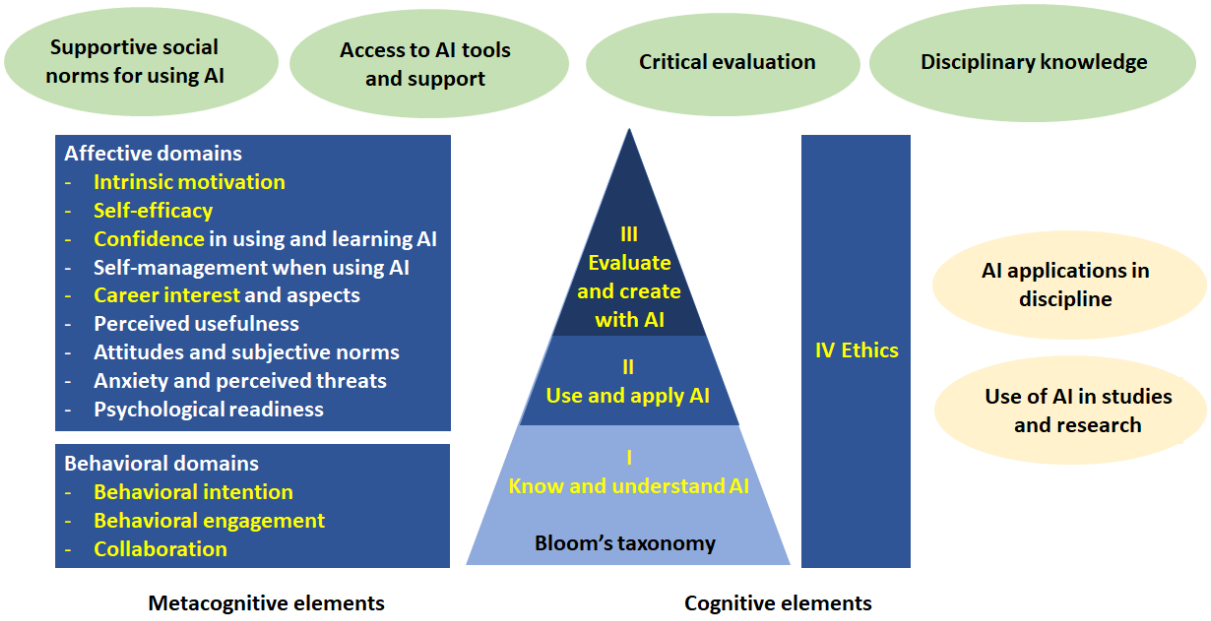

Figure 1: Framework of AI Literacy and Related Aspects for Curriculum Planning Discussion. Items in yellow font were modified from Ng et al. (2021), Ng et al. (2022) and Ng et al. (2023). Other references: Chai et al. (2021); Dai et al. (2020); Carolus et al. (2023); Wang et al. (2023); Fundi et al. (2024); Kong, Cheung, and Tsang (2024).

4. AI Literacy in Curriculum Planning in Agricultural Sciences

The general structure of the BSc Agricultural Sciences programme includes foundational science courses of scientific bases, the discipline itself and general work-life skills. A general pedagogical framework for the curriculum and course structures is constructive alignment (Biggs & Tang, 2011), including targeted learning outcomes (Krathwohl, 2002) for both the BSc degree and individual courses.

Finnish universities formulate their curricula independently (OKM, 2009; Holmén, 2022). There is a lot of autonomy, with the curricula being written by teachers (i.e., professors, lecturers, degree programme directors). Degree programme-specific curricula are designed and drafted in accordance with university-wide principles and guidelines (Pietikäinen et al., 2024). The curricula are approved by faculty councils as proposed by the degree programme executive boards. Curriculum planning at the University of Helsinki's Faculty of Agriculture and Forestry includes defined aims and deadlines, as well as individual and collaborative working by teachers. Students are also involved in certain phases of the planning. UNESCO (2023) suggests even wider collaboration with other stakeholders such as researchers, copyright experts, and AI providers and engineers when it comes to system-level curriculum planning. The visual framework summarising the literature on AI literacy (Section 3.4, Figure 1) will help in discussions between all participants involved in developing the curriculum for Agricultural Sciences.

In China, Dai et al. (2020) stated that the knowledge and skills constituting AI literacy are often included in learning objectives when developing curricula, keeping the future society in mind. The introduction of AI concepts and applications in various subjects and grade levels

was recommended by the International Society for Technology in Education (ISTE, 2023). Southworth et al. (2023) stated that AI theories and applications should be integrated in higher education curricula, rather than being only a small additional element in courses. They listed five categories related to the learning of AI in the University of Florida's curricula (ibid.):

1) Skills (courses) that enable understanding of AI, e.g., programming and statistics;
2) Knowledge, understanding and applications of the basic functions of AI;
3) Ethics of AI;
4) Using and applying AI;
5) Higher order thinking skills: evaluating and creating AI.

At a Swiss university of applied sciences, Walter (2024) recommended both AI literacy courses and the integration of training in the use of AI into different courses in the curriculum. The Faculty of Bio-Science Engineering at the University of Gent, Belgium, currently aims to integrate generative AI (or, more broadly, digital competencies) into its curriculum (Uyttendaele & De Caluwé, 2024).

Based on the literature and benchmarking of other universities, our intention is to visibly include AI in the next four-year curriculum (aims, learning outcomes, course activities, evaluation) of the degree programme, although not on every single course. Existing resources and possibilities to be discussed collegially within the Department (and perhaps also within the Faculty) are listed in Table 3.

Table 3: Existing and Future Resources and Actions at Different Organisational Levels at the University of Helsinki, Concerning Suggestions and Recommendations About AI. Agr. Sci. = Agricultural Sciences, FAF = the Faculty of Agriculture and Forestry.

Resource or action concerning AI in curriculum	**University of Helsinki**	**Department and BSc Agr. Sci. programme (possibly FAF)**
Fostering an environment that promotes AI: encouraging questioning, exploring, and critical assessment of AI (Walter, 2024)	- Guidelines for using AI in teaching (UH, 2024b) - AI workshops for teachers - Regular updates for teachers about AI	- Assistant Professor in distributed AI in agriculture 2024->* - AI workshops for teachers? - Examples of AI exercises and rules for courses (possible future action in Agr. Sci.) - Pedagogical Moodle page for Agr. Sci. teachers (Kymäläinen et al., 2023)
AI training for teachers (Walter, 2024)	Currently eight AI MOOC courses	- Teacher meetings - Curriculum workshops (FAF) - Possibly AI workshops for teachers
Equitable access to AI tools for students (Dai et al., 2020; Song, 2024; Walter, 2024)	GenAI tool Curre.chat (UH, 2024a), reference searching application Keenious (UH, 2024c)	- Information for teachers about the tools - Examples of AI exercises and rules for courses
Agricultural students' research about AI		Studies about the AI readiness of BSc Agr. Sci. and FAF students (Elo et al., 2024; Kymäläinen, Elo, and Södervik, 2024b; unpublished data)
Teaching and curriculum adaptation (Dai et al., 2020; Southworth et al., 2023; Walter, 2024)		- AI workshops for Agr. Sci. students, grant by FAF in 2024 (Kymäläinen, von Cräutlein, Elo, Galambosi, and Honkanen, 2024a); currently voluntary, but voluntary or obligatory in the future? - Integrating learning of AI into work-life skills courses and some disciplinary courses by the teachers responsible (Pietikäinen and Kymäläinen 2024) - What about particular courses focusing on AI? - AI as a work-life skill for students to be discussed in BSc portfolios - Collecting AI exercise experiments - Discussions of the steering committee of the BSc Agr. Sci. programme - Curriculum workshops, departmental and subfield teacher meetings

Pedagogical approaches for AI literacy include discovery and inquiry-based learning, collaborative learning, constructionism, project- or problem-based learning, storytelling, and hands-on or playful learning (Ng et al., 2021). Assessment methods may need to be re-evaluated in the GenAI era (Francis, 2024). Recent Agricultural Sciences curricula have been updated using a practical and simple pedagogical spreadsheet tool: the constructive alignment table, which includes elements of the course concept (includes 7 sub items), course activities for students (10 items) and evaluation (8 items) laid out in a spreadsheet (Kymäläinen et al.,

2023). Core contents and targeted learning aims are also presented in columns. Examples and instructions for teachers are presented in a second sheet of the spreadsheet. The teachers responsible add check marks to the elements included in individual courses. AI is not mentioned in the current version of the alignment table. The AI framework (Section 3.4, Figure 1), can be used in planning the curricula frame and developing the spreadsheet planning tool.

Table 4: Possibilities for the Inclusion of AI in the BSc Agricultural Sciences Programme's Constructive Alignment Table.
'Column' indicates there will be a space in the spreadsheet for check marks to be made by the teacher responsible for the course. GenAI = generative AI.

Option	Addition to the constructive alignment table tool	Comments
A	One column for AI in the course activities section	This is a minimum option. Practical examples from options B and C, examples of course assignments and GenAI rules are mentioned in the second sheet of the spreadsheet.
B	Two columns for AI: a) AI applications in agriculture b) GenAI in course assignments	Practical examples from option C, examples of course assignments and GenAI rules are mentioned in the second sheet of the spreadsheet.
C	Several columns for AI, e.g.: a) AI applications in agriculture b) GenAI in course assignments c) GenAI rules are mentioned in course assignments d) GenAI is included in course assignments e) Different domains of AI literacy (Figure 4) are mentioned in columns	Examples of GenAI rules and course assignments are mentioned in the second sheet of the spreadsheet.

5. Conclusions

For Agricultural Sciences students, there are two main areas in which AI literacy is important: agricultural AI applications, and the use of AI in studies and research. Generative AI (GenAI) is considered to be included in both of these two main use areas.

In this literature survey, an AI literacy framework was sketched to be used in collegial discussions for curriculum planning in the BSc Agricultural Sciences programme. Although there is no established definition of AI literacy, key elements were derived from the literature. These include cognitive elements related to knowledge and skills about the content, applications, use, ethics, evaluation and creation of AI, as well as metacognitive elements (affective and behavioural domains). Further important perspectives on AI literacy include targeted learning outcomes organised according to Bloom's taxonomy, social norms, access to AI tools, critical evaluation and disciplinary knowledge.

Finnish university teachers have a high degree of autonomy in planning the curricula. Curriculum planning includes possibilities for collegial discussion. The University of Helsinki has outlined basic guidelines for AI in studies and teaching. We see it as useful to

include AI teaching in the next Agricultural Sciences curriculum, and have suggested topics and questions to be discussed regarding the inclusion of AI literacy in the forthcoming Agricultural Sciences curriculum.

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