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Designing relevant Precision Agriculture training courses for technical advisors

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Abstract

Technical advisers (TA) are considered as key stakeholders in the adoption of Precision Agriculture (PA) tools by farmers. However, they are relatively poorly trained in PA tools. Existing training courses are generally not really adapted to their needs. This paper explores the opportunity of the Competency Based Approach (CBA) to design a training course on PA that is adapted to the TA needs. In this study, a group of 15 PA experts including suppliers, distributors, users, teachers and researchers identified i) the Reference Professional Situations (RPS) that TA may experience, ii) the PA technologies they may be expected to handle and iii) the skills required for each PA technology and each RPS. These proposals were validated and completed by a larger group of 90 experts. The results of this study showed that CBA was a relevant approach for designing training modules on PA for agricultural professionals.

Keywords: Competency based approach; competency-based education; Skill; Teaching

Introduction

Precision Agriculture (PA) has been developing for several decades (Tey and Brindal, 2022). However, adoption levels of these technologies remain relatively low (Lowenberg-DeBoer and Erickson, 2019). Several studies have shown that one of the main barriers to the development of PA is the lack of training of Technical Advisers (TA) in PA tools (Markley and Hughes, 2013; Tey and Brindal, 2022). A TA supports and advises farmers. They are considered as key stakeholders in assisting farmers in the implementation of PA tools and methods (Reetz, 2002). However, very few of these TA have the required skills either to use PA technologies or to advise farmers in using them (Fausti et al., 2021). In France, TA are not well trained in PA technologies because dedicated training remains rare and often not adapted to their expectations (Vivea, 2020). The training often focuses only on specific technology principles, whereas a TA needs to understand how to integrate these tools into their technical and agronomic expertise. The design of training courses for TA is an important lever to foster the adoption of PA tools. It requires a more systemic approach capable of integrating and linking different technologies to the TA daily work missions. As PA technologies are constantly evolving, academics are frequently asked to design “up to date” training courses as they maintain a regular technology overview, whether through their research activities or through projects carried out in partnership with PA service companies. However, academics often favour disciplinary teaching approaches that focus on the physical and organisational principles of the PA solutions available in agriculture. As a result, training designed by academics, although of very high quality, often does not appeal to and/or does not interest a TA because they seem too far from daily work situations. This observation, at least in France, requires the implementation of relevant approaches to support academics (and other

stakeholders) in designing PA training courses based on the requirements of the TA profession. The Competency Based Approach (CBA) seems to be a relevant method to meet this challenge.

Indeed, the CBA is an approach for designing training courses on the basis of the professional situations experienced by the learners. This approach makes it possible to identify the competencies needed to cope with each professional situation. It is often used for the design of university courses (Orekhova et al., 2019) but it is more rarely used for the training of professionals and, to the authors' knowledge, it has never been implemented for the design of training for professionals in PA. The purpose of this paper is i) to present the methodology used to identify the specific professional situations experienced by a TA in PA, ii) to show how specific competencies were derived from these later, iii) to present some results obtained with the CBA and their potential to design a PA training course for TA. This paper aims to implement the CBA by gathering PA experts' opinions.

Materials and methods

General methodology

The approach proposed in this study was a Competency Based Approach (CBA) (Gervais, 2016). In this paper, competencies will be referred as skills. The CBA aims at defining the content of a training course based on Reference Professional Situations (RPS). It consists in two steps. In a first step, a limited number of RPS to which the training course must provide answers are identified and defined. In a second step, the skills to be acquired to cope with each of these RPS are listed. In this study, this approach was implemented by collecting opinions of experts in PA both on RPS and on skills. Those experts were selected because they interact with TA on a daily basis as employers, customers or suppliers. The objective was to create an exhaustive panel of stakeholders that are familiar with the different aspects of TA's jobs.

Selection of experts

The method was implemented in the context of AgroTIC Business Chair at the Institut Agro Montpellier (www.agrotic.org). The AgroTIC Business Chair is a consortium that brings together 1 research institute, 2 universities and 27 companies. One of the challenges of the Chair is to bring together collective dynamics to meet the needs in education and the appropriation of new technologies in agriculture (Lachia et al., 2019). The AgroTIC Business Chair involves companies that are suppliers (e.g. software editor or agricultural machinery), distributors or users of hardware or software PA tools (e.g. agricultural cooperative). Two groups of experts were defined within the Chair. The first group, made up of volunteers, consisted of 15 experts with a large range of expertise in software and hardware for PA and in the knowledge of TA's missions (Table 1). Experts included 5 suppliers, 3 distributors, 4 users and 3 teachers and researchers. The objective of this group was to have a number of experts that was both small enough to work effectively and large enough to consider the diversity of a TA's jobs and actions in agriculture. This group proposed a first version of the RPS and skills. The second group consisted of 90 experts, all the members of the AgroTIC Business Chair, including 32 suppliers, 25 distributors, 20 users and 13 teachers and researchers. The aim of this second group was to be as broad as possible to make sure that the diversity of a TA's jobs and

missions were exhaustively taken into account. This group responded to the proposals made by the first group of experts by modifying or completing them.

Table 1. Level of expertise in software, hardware and Technical Advisors' (TA) missions for the 15 selected experts. High level of expertise is represented in dark green, medium level of expertise in light green and basic knowledge in yellow.

Field of expertise	Experts														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Software for PA															
Hardware for PA															
TA's missions															

Organisation of workshops

The first group of 15 experts participated in 4 workshops (Figure 1). During the first workshop, the experts defined a common definition of TA's jobs using the Persona method (Cooper, 1999). The objective of this method was to provide a common representation of a type of stakeholder (here the TA) in order to embody the situations they might face in the future (here the RPS). It consisted in defining a fictive person with realistic characteristics. This person is supposed to personify the stakeholder under consideration and its needs in term of skills (Bornet and Brangier, 2013). On the basis of this persona, the 15 experts defined the RPS's that were assumed most frequently encountered. During the second workshop, the 15 experts listed and defined all the PA technologies that a TA might be confronted with. In the third workshop, they defined the skills (see following section) to be mastered by the TA for each PA technology and each RPS. Finally, during the fourth workshop the 15 experts homogenised the list of skills in order to avoid duplication and ensure consistency. The objective of this stage was to produce a deliverable consisting of a document to be shared which defined the persona, the RPS that this later was supposed to be confronted to, the PA technologies to be mastered and the associated skills. Subsequently, the group of 90 experts consulted and then modified or completed the document. The group of 90 experts also decided by what mean they would share their work with agricultural professionals. The four workshops were organised remotely in the form of video conferences. Between the meetings, the documents were shared online and could be amended, completed and corrected by all the experts of each group.

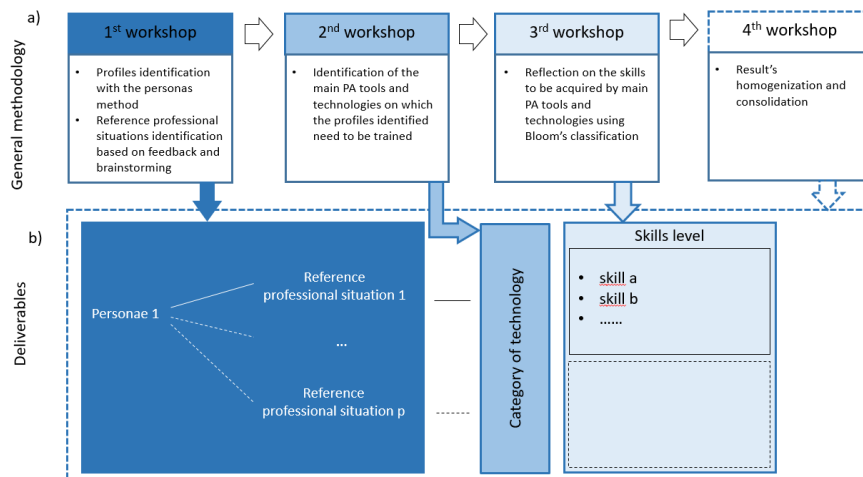


Figure 1. Implemented methodology and deliverables for each of the 4 workshops.

Definition of skills

The skills have been defined on the basis of Bloom's taxonomy (Krathwohl, 2002). This taxonomy is a model of courses design that groups learning objectives, from the simplest to the most complex. The Bloom's taxonomy considers six classes of learning objectives: knowledge, understanding, application, analysis, evaluation and design. This taxonomy defines action verbs associated with each of the levels, thus making it possible to formulate learning objectives. For example, the action verbs for the "understanding" category may be: contextualise, give examples, explain or reformulate. Bloom's taxonomy offered a framework allowing each learning objective and its degree of complexity to be identified. In this study, this taxonomy was used to formulate the skills and to evaluate their respective level of complexity (from 1 to 6) that was required by the TA to face the RPS.

Results and discussion

Persona and reference professional situations

The experts chose to define the persona of Thierry, 45-year-old, to illustrate the TA profession (Figure 2.a). According to them, Thierry's role is to act as an interface between the farmers and the specialists of his organisation. His organisation can be a cooperative or an agro-distributor. His mission is to support his organisation in building a commercial offer and distributing the digital services commercialised to farmers in the field. Thierry has to adapt his advice to the farmers he works with.

The experts identified four reference professional situations (RPS) that Thierry regularly faces (Figure 2.b). They ranked these situations from 1 to 4 according to the complexity of the skills they require. According to the experts, in these four reference work situations, Thierry seeks to remain up to date in his knowledge and understanding of the PA tools in order to be able to propose a commercial offer for his organisation (RPS n°1), to support farmers in choosing PA tools according to farm characteristics and farmer concerns (RPS n°2) and to use them according to their context and skills (RPS n°3) and finally he seeks to use PA and digital tools to optimise his way of working (RPS n°4).


<p>a)</p>  <p>Thierry, 45 years old, Technical advisor</p> <p>His role :</p> <ul style="list-style-type: none"> - helping to build a commercial offer, - distributing the digital services to farmers - making advices to farmers depending on their specific context. 	<p>b)</p> <table border="1"> <thead> <tr> <th>N°</th><th>Reference professional situations</th></tr> </thead> <tbody> <tr> <td>1</td><td>Thierry wishes to stay up to date, to get informed and to understand how PA tools work in order to develop a commercial offer for his organization.</td></tr> <tr> <td>2</td><td>Thierry needs to develop an argumentation to help farmers choosing their PA tools.</td></tr> <tr> <td>3</td><td>Thierry must help farmers in handling a PA tool, according to their skills and the context of their farms.</td></tr> <tr> <td>4</td><td>Thierry wants to be able to use PA tools in order to optimize the way he works.</td></tr> </tbody> </table>	N°	Reference professional situations	1	Thierry wishes to stay up to date, to get informed and to understand how PA tools work in order to develop a commercial offer for his organization.	2	Thierry needs to develop an argumentation to help farmers choosing their PA tools.	3	Thierry must help farmers in handling a PA tool, according to their skills and the context of their farms.	4	Thierry wants to be able to use PA tools in order to optimize the way he works.
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Figure 2. Illustration of a persona and the corresponding reference professional situations identified by experts.

RPS n°1, 2 and 3 correspond to Thierry's core business as a TA and the experts considered that they play a major role in the adoption of PA tools by farmers. These RPS were quickly

identified by the 15 experts during the 1st workshop. RPS n°4 is less directly linked to the adoption of PA tools by farmers. However, the 90 experts who were subsequently consulted considered that this fourth RPS was at the heart of the daily concerns of the TA.

Main PA tools and technologies on which a TA needs to be trained

The experts identified 12 categories of technologies that need to be mastered by a TA to deal with these four RPS (Table 2). They identified a basic category that corresponds to the acquisition by a TA of a general overview of the digital tools and stakeholders (main companies, typology of PA services providers, etc.) of the ecosystem. They also identified technologies that are more software-based (e.g. Farm Management Information System, Modelling, etc.) and others that are more hardware-based (e.g. Internet of Things, consoles and terminals, etc.). Finally, the experts considered that the ability of TA to demonstrate the potential of digital tools for farmers (Return On Investment, time savings, comfort gains, etc.) was essential for the adoption of these tools. They therefore identified a final category that corresponds to the specific techniques for selling digital tools in agriculture.

Table 2. Main PA technologies identified by experts to cope with the professional situations.

Category of technology	Definition and details
Initiation to digitals tools	Global overview of the digital ecosystem in agriculture and the main stakeholders.
FMIS	Farm Management Information System (FMIS): Information system where technical and economic data is stored.
DST / Modelization	Decision Support Tools (DST) and agronomic modeling (at the plant, field or farm level).
Remote sensing	From image acquisition by drones, airplanes, satellites, etc. to production of agronomic indicators.
IoT	Internet of Things (IoT); Sensors and telecommunication: from data acquisition to information transfer via different networks (3G, WiFi, LoRa).
Geolocation	Different positioning systems: their characteristics, their accuracy and their uses.
EDI	Electronic Data Interchange (EDI); ISOBUS and AEF (Agricultural Industry Electronics Foundation).
Consoles and Terminals	Tractor consoles; Terminals; File formats; Setup.
Geographic data in consoles	Management of geographic data in the consoles.
Data	Data regulation and ethics. General regulations about data protection.
Robot	Robotics; Autonomous machines.
Business	Sales techniques related to digital services.

It is interesting to note that although robotics is not yet widely adopted by farmers for crop production (Lachia et al., 2019), it was identified by the experts as a technology on which the TA should be trained. The experts anticipated the emergence of this technology and the need to train a TA now to support farmers in this change in the future.

Level of expertise required for each PA technology to cope with the identified professional situations

The experts identified 14, 23, 24 and 18 skills respectively for RPS n°1, 2, 3 and 4. As an illustration, Figure 3.a shows the 24 skills identified for RPS n°3. The experts identified skills to be mastered by the TA for each of the PA technologies (Figure 3.a). These skills correspond to levels 1 and 2 and only up to 4 of Bloom's taxonomy. The same results were observed for RPS n°1, 2 and 4. Figure 3.b illustrates how the skills were formulated by the experts, detailing those associated with the Internet of Things (IoT) technology. According to the experts, in order to be able to help farmers in their use of this technology (RPS n°3), the TA must i) know the types of sensors and their mode of communication (level 1), ii) understand the uses of these technologies in agriculture (level 2) and iii) be able to apply an argument on the benefits of these technologies to a real case (level 3). According to these results, a TA needs to master a wide spectrum of PA technology but basic skills seem sufficient to cope with the RPS they encounter.

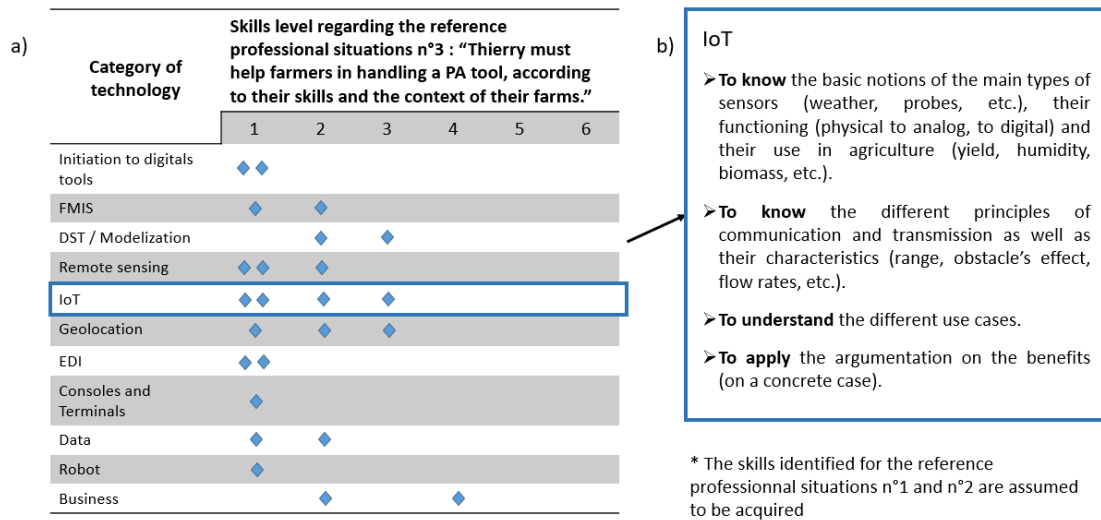


Figure 3. Illustration of a skills reference framework obtained for the persona "Thierry" and the professional situation of reference n°3

It is worth noting that experts only identified skills at or below level 4 in Bloom's taxonomy. This result corresponds to the TA's missions of understanding and supporting PA adoption. It seems that CBA helped to identify skills that are specific to a TA's jobs and to the situations they are facing in their daily professional missions. It is likely that if the same study were performed for master's students, RPS would be more focused on the design of PA tools or services and, as a consequence, the corresponding skills would show higher levels in Bloom's taxonomy. In other domains (Orekhova et al., 2019), it has also been shown that master's students do not consider themselves sufficiently well trained in PA and that they need training corresponding to the professional situations they encounter (Bournaris et al., 2022). CBA seems to present interesting opportunities to tackle these issues.

Generalisation of the approach

This paper has briefly presented the results of the proposed methodology on a TA. For reasons of space, this paper has focused exclusively on TAs. Indeed, TAs are considered to be the key stakeholder in facilitating the adoption of PA technologies. However, the

approach has also been used to define the RPS and skills for other stakeholders involved either in PA technologies use or dissemination. For each of these profiles, the same method was applied. This led to the definition of two other personas : i) Léa, a 34 years old farmer whose concerns (and associated RPS) are either to invest in PA technologies adapted to her context or to become more self-reliant in the use of PA technologies, ii) Pierre, a 27 years old agricultural machinery advisors working for a machine retailer/dealer whose concerns (and associated RPS) are either to remain up to date on his knowledge and understanding of PA tools in order to be able to propose commercial offers, to support farmers in choosing PA tools according to their concerns and their farm characteristics and finally to help farmers solving the problems they might encounter in using PA tools.

For all these profiles, the results of the study were similarly disseminated in the following section.

Dissemination of results

The aim was to disseminate the results as widely as possible in order to provide a resource for a large variety of stakeholders in designing training for TA. Experts promoted the dissemination in the form of a booklet available online (https://www.agrotic.org/wp-content/uploads/2019/10/220328-Doc_formation_continue_web_liens.pdf). The purpose of this booklet was to assist training organisations in setting up professional training courses on PA. They also included in the booklet, the results of the study conducted on two other profiles, farmers and agricultural machinery advisors. Experts considered that these profiles were the most important to train in order to promote the adoption of PA.

Conclusions

This paper explored the potential of a Competency Based Approach for designing a PA training course adapted to technical advisors' needs. From a large panel of experts, a persona representing the technical advisers and the situations they might face was defined. The approach proved to be relevant in defining the skills to be acquired on the basis of job-related issues, which makes it possible to change from a more traditional disciplinary approach as usually followed in the academic field. On the basis of the results, two training courses of 3 days with 15 TAs have already been successfully set up on to support RPS n°1 and 2.

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