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Assessment of the Environmental Coordinators' Competencies Using a Serious Game: A Case Study

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Abstract. The present paper aims to present a case study carried out in the engineering national school of applied sciences situated in Tangier, Morocco, that intends to assess the competencies of future environmental coordinators by using a serious game named "EnviRun". The environmental coordinators have a major role in the industries since they ensure that the requirements related to the ISO 14001:2015 international standard are well applied in the field. The assessment approach proposed in this paper involves several steps including the identification of the competencies required by the environmental coordinators, game design, assessment of the competencies level using the interval 2-tuple linguistic approach, and measurement of the distance between the acquired and required competencies level that allow us to define the competencies that need a deeper training.

Keywords: Serious game, interval 2-tuple, competency, competency assessment, environment.

1. Introduction

Due to the growing impact of the industrial activities environmental on the environment and an increasingly strict environmental legislative framework, industries are more and more interested in improving their environmental performance. Thus, several industries have implemented an environmental management system according to the ISO 14001:2015 international standard. For the success of this system, human capital plays a major role. Thus, environmental jobs are increasingly demanded in the industrial sector, especially the environmental coordinators whose main mission is to ensure that the requirements of the ISO 14001:2015 standard have been well implemented in the field. Furthermore, the industries are required to ensure that their collaborators are competent on the basis of an appropriate initial or professional training, and identify the training needs [1]. Consequently, having an efficient approach that helps to assess the competencies and determine the training needs is of primary importance.

There are several competency assessment methods in the literature such as interviews and tests. However, these methods can generate a lot of stress, which does not always allow to evaluate the real potential of the candidates. This is why we proposed in a previous study [2] the EnviRun serious game that allows to assess the participants' competencies, while allowing them to have fun. Moreover, competency assessment can be carried out by using a quantitative or qualitative scale. In order to get closer to human reasoning, the use of a qualitative scale is more appropriate. For this purpose, there are several methodologies in the literature such as fuzzy sets developed by Zadeh [3] and it's extensions. However, they are less precise and flexible when dealing with qualitative scales than the interval 2-tuple linguistic approach.

This study lies within this context, and aims to present a case study carried out with professionals following a continuous training cycle at the engineering national school of applied sciences, situated in Tangier, Morocco. Therefore, the adopted approach involved several steps including the identification of the competencies required by the environmental coordinators, development of a new version of the EnviRun serious game that includes the identified competencies , assessment of the acquired and required competencies level by using the interval 2-tuple linguistic approach, and measurement of the distance

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between the acquired and required competencies level, which allows to determine the competencies that need a further training.

The present paper is organized as follows. In section II, a brief introduction of some definitions related to the 2-tuple and interval 2-tuple linguistic variables will be highlighted. Thereafter, the proposed competency assessment approach will be described in section III. Afterwards, the results of the case study and their discussion will be presented in section IV. Finally, some conclusions and perspectives will be pointed out in section V.

2. Preliminaries

2.1. 2-tuple linguistic variables

The 2-tuple representation model was first introduced by Herrera and Martínez [4]. In this model, a 2-tuple linguistic variable is described as (s_i, α), where s_i is a linguistic variable and α is a symbolic translation. Let us introduce some definitions:

Definition 1: Let $S = \{s_0, s_1, ..., s_g\}$ be a linguistic term set and $\beta \in [0,1]$ a value representing the result of a symbolic aggregation operation, then the generalized translation function (Δ) that translates β into a 2-tuple linguistic variable is given by the following function [5]

$$\begin{aligned} &\Delta : [0,1] \to S \times \left[-\frac{1}{2g}, \frac{1}{2g} \right) \\ &\Delta(\beta) = (s_i, \alpha) \text{ with } \begin{cases} s_i, & i = \text{round}(\beta \bullet g) \\ \alpha = \beta - i/g, & \alpha \in \left[-\frac{1}{2g}, \frac{1}{2g} \right) \end{cases} \end{aligned} \tag{1}$$

The reverse function Δ^{-1} that returns the equivalent numerical value $\beta \in [0,1]$ of a 2-tuple is given by equation (2) [5]:

$$\begin{aligned} &\Delta^{-1} : S \times [-0.5/g, 0.5/g) \to [0,1] \\ &\Delta^{-1}(s_i, \alpha) = \beta = i/g + \alpha \end{aligned} \tag{2}$$

According to Herrera and Martinez [4]. The comparison between two 2-tuples (s_i, α_i) and (s_j, α_j) is obtained as follows:

- When, $i < j$, then, $(s_i, \alpha_i) < (s_j, \alpha_j)$
- When, $i = j$
  - If $\alpha_i = \alpha_j$ $\alpha_i = \alpha_j$ then, $(s_i, \alpha_i) = (s_j, \alpha_j)$
  - If $\alpha_i < \alpha_j$ then, $(s_i, \alpha_i) < (s_j, \alpha_j)$
  - If $\alpha_i > \alpha_j$ then, $(s_i, \alpha_i) > (s_j, \alpha_j)$

2.2. Interval 2-tuple linguistic variables

Zhang [6] presented the interval 2-tuple linguistic variables that are considered as a generalization of the 2-tuple linguistic variables. In the following, some definitions will be introduced:

Definition 2: Let $S = \{s_i \mid i = 0,1,2,...,g\}$ be a linguistic term set. An interval 2-tuple linguistic variable is composed of two 2-tuples, denoted by $[(s_i, \alpha_1), (s_j, \alpha_2)]$, where $i \le j$, $s_i (s_j)$ and $\alpha_1 (\alpha_2)$ represent the linguistic label of the predefined linguistic term set S and symbolic translation, respectively. An interval value $[\beta_1, \beta_2]$ $(\beta_1, \beta_2 \in [0,1], \beta_1 \le \beta_2)$ can be converted into an interval 2-tuple linguistic variable as follows [6]:

$$\Delta([\beta_1,\beta_2])=\left[(s_i,\alpha_1),(s_j,\alpha_2)\right] \text{ with } \begin{cases} s_i, & i=\text{round}(\beta_1 \bullet g) \\ s_j, & j=\text{round}(\beta_2 \bullet g) \\ \alpha_1=\beta_1 - i/g, & \alpha_1 \in \left[-\frac{1}{2g},\frac{1}{2g}\right) \\ \alpha_2=\beta_2 - j/g, & \alpha_2 \in \left[-\frac{1}{2g},\frac{1}{2g}\right) \end{cases} \tag{3}$$

The reverse function, that converts an interval 2-tuple linguistic variable can be converted into an interval value into an interval value $[\beta_1,\beta_2]$ $(\beta_1,\beta_2 \in [0,1],\beta_1 \le \beta_2)$ is given as follows [6]:

$$\Delta^{-1}\left(\left[(s_i,\alpha_1),(s_j,\alpha_2)\right]\right)=[\beta_1,\beta_2]=[i/g+\alpha_1, j/g+\alpha_2] \tag{4}$$

Definition 3: Let $\tilde{a}=\left[(s,\alpha),(s',\alpha')\right]$, $\tilde{a}_1=\left[(s_1,\alpha_1),(s_1',\alpha_1')\right]$ and $\tilde{a}_2=\left[(s_2,\alpha_2),(s_2',\alpha_2')\right]$ be any three interval 2-tuples and let $\lambda \in [0,1]$, then their operations are defined as follows [7]

$$\begin{aligned} \tilde{a}_1 \oplus \tilde{a}_2 &= \left[(s_1,\alpha_1),(s_1',\alpha_1')\right] \oplus \left[(s_2,\alpha_2),(s_2',\alpha_2')\right] \\ &= \Delta\left[\Delta^{-1}(s_1,\alpha_1)+\Delta^{-1}(s_2,\alpha_2),\Delta^{-1}(s_1',\alpha_1')+\Delta^{-1}(s_2',\alpha_2')\right] \end{aligned} \tag{5}$$

$$\begin{aligned} \lambda\tilde{a} &= \lambda\left[(s,\alpha),(s',\alpha')\right] \\ &= \Delta\left[\lambda\Delta^{-1}(s,\alpha),\lambda\Delta^{-1}(s',\alpha')\right] \end{aligned} \tag{6}$$

Definition 4: Let $\tilde{a}_1=\left[(s_1,\alpha_1),(s_1',\alpha_1')\right]$ and $\tilde{a}_2=\left[(s_2,\alpha_2),(s_2',\alpha_2')\right]$ be any two interval-valued 2-tuple linguistic variables. The distance (d_{ITD}) between $\tilde{a}_1$ and $\tilde{a}_2$ is defined as: [7]

$$d_{ITD}(\tilde{a}_1,\tilde{a}_2)=\Delta\left[\frac{1}{2}\left(\left|\Delta^{-1}(s_1,\alpha_1)-\Delta^{-1}(s_2,\alpha_2)\right|+\left|\Delta^{-1}(s_1',\alpha_1')-\Delta^{-1}(s_2',\alpha_2')\right|\right)\right] \tag{7}$$

Definition 5: Let $\tilde{a}_i=\left\{\left[(s_i,\alpha_i),(s_i',\alpha_i')\right]\right\}(i=1,2,...,n)$ be a set of interval-valued 2-tuples, $w=(w_1,w_2,...,w_n)^T$ is the weight vector of regarding interval 2-tuple, with $w_i \in [0,1]$ and $\sum_{i=1}^{n} w_i=1$. The Interval-Valued 2-tuple Weighted Average (IVTWA) is given as follows [6]:

$$\text{IVTWA}(\tilde{a}_1,\tilde{a}_2,...,\tilde{a}_n)=\Delta\left[\sum_{i=1}^{n} w_i\Delta^{-1}(s_i,\alpha_i),\sum_{i=1}^{n} w_i\Delta^{-1}(s_i',\alpha_i')\right] \tag{8}$$

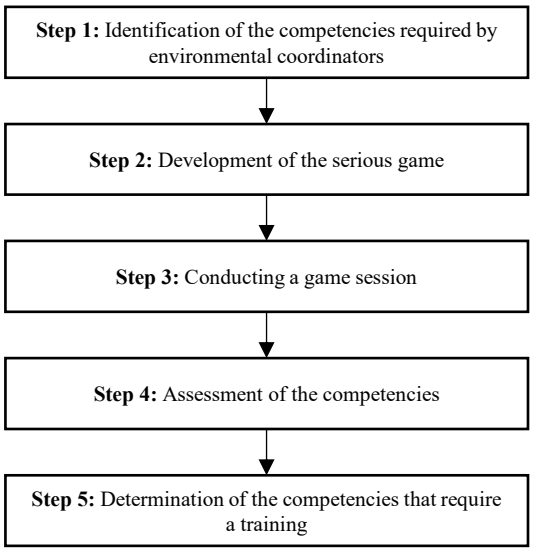

Fig. 1: The proposed competency assessment approach

3. The proposed competency assessment approach

The assessment approach proposed in this paper includes five steps as illustrated in Fig.1. Each step will be described in the next subsections.

3.1. Identification of the competencies required by environmental coordinators

Environmental coordinators play a major role in the continuous improvement of an organization's environmental management system. They are interlocuters the environmental manager and the field staff. Their main mission is to check whether the environmental procedures, and the requirements of the ISO 14001:2015 standard have been respected or not. Furthermore, they can propose solutions to improve the environmental performance. To achieve that, many competencies are required. Therefore, we conducted a study that aims to identify the competencies required by the environmental coordinators. The identification process was based on the requirements of the ISO 14001:2015 international standard and some job descriptions of some Moroccan industries. Three main competency categories were considered: Knowledge, know-how, and know-whom [8]. More than 40 competencies were identified. Table 1 presents an extract.

Table 1: Competencies required by the environmental cordinators position (Extract)

Competency category	Competencies (Examples)
Knowledge	To know the company's activities and processes
	To know the requirements of the ISO 14001:2015
	To know the environmental aspects and impacts
Know-how	To identify and analyze non-conformities
	To control the application of waste management procedures
	To monitor the regulatory compliance
Know-whom	Teamwork
	To show sense of continuous improvement
	To have communication skills

3.2. Development of the serious game

Once the competencies were identified, the next step was to develop the serious game. To this end, a second version of the serious game "EnviRun" [2] was proposed that includes all the competencies required by the environmental coordinators. The game rules have not changed. However, some topics have been added. In fact, EnviRun has six main topics, which are: ISO 14001:2015, Energy, solid wastes, air and water, environmental legislation and case studies. Each topic includes several open questions, multiple choice questions or role-playing situations that are well adapted to the environmental coordinators position. For instance, the question "According to the ISO 14001:2015 standard, the organization must establish a life cycle analysis, true or false?" was introduced in the ISO 14001:2015 topic.

3.3. Conducting a game session

A face-to-face game session is recommended, because it allows to assess the know-whom competencies, which is difficult to carry out in an online session. To conduct the game session, the game facilitator, appraisers, and participants are needed. Furthermore, a set of n competencies $P_j\left(j=1,2,...,n\right)$, and the questions related to them have to be selected. The session is carried out as follows: First the facilitator explains the game rules to the participants and give the assessment grid to the appraisers. This grid includes the competencies, the assessment scale S={s_0=Extremely Low (EL), s_1= Very Low (VL), s_2= Low (L), s_3= Medium (M), s_4= High (H), s_5= Very High (VH), s_6= Extremely High (EH)}, and the name of the participants $A_i\left(i=1,2,...,m\right)$. Thereafter, the facilitator picks the cards related to the position of each participant in the game, asks the related question, and so on until the game ends. Finally, each appraiser $E_k\left(k=1,2,...,K\right)$ provides its assessments.

3.4. Assessment of the competencies

As explained in [2], each appraiser E_k ($k=1,2,...,K$) will select linguistic terms from the linguistic term set *S* to assess the level of competencies acquired by each participant $A_i\,(i=1,2,...,m)$. Thereafter, theses assessments will be converted into interval 2-tuple linguistic variables as follows:

- A grade such as Very Low (VL) can be written as $\left[(s_1,0),(s_1,0)\right]$
- An interval grade such as Low-Medium (L-M), means that the given assessment is between Low and Medium, $\left[(s_2,0),(s_3,0)\right]$

Therefore, let $\tilde{C}_k=\left(\tilde{C}_{jj}^k\right)_{m\times n}=\left(\left[\left(sa_{ij}^k,0\right),\left(ta_{ij}^k,0\right)\right]\right)_{m\times n}$ be an interval 2-tuple linguistic assessment matrix corresponding to the acquired competency level where, $\tilde{C}_{jj}^k$ represents the interval 2-tuple value related to the linguistic information provided by E_k $(k=1,2,...,K)$ on the assessment of the competency $P_j\,(j=1,2,...,n)$ acquired by the environmental coordinator $A_i\,(i=1,2,...,m)$; $sa_{ij}^k,ta_{ij}^k\in S$ and $sa_{ij}^k\le ta_{ij}^k$ $i=1,2,...,\mathrm{m}$ $j=1,2,...,\mathrm{n}$ $k=1,2,...,K$.

The assessments of all appraisers regarding the acquired competencies level are then aggregated to construct a collective interval 2-tuple linguistic assessment matrix $\tilde{C}=\left(\tilde{c}_{ij}\right)_{m\times n}$, where $\tilde{c}_{ij}$ is given by equation (9).

$$\begin{aligned}\tilde{c}_{ij}&=\left(\left[\left(sa_{ij},\alpha a_{ij}\right),\left(ta_{ij},\varepsilon a_{ij}\right)\right]\right)_{m\times n}=\mathrm{IVTWA}\left(\tilde{c}_{ij}^1,\tilde{c}_{ij}^2,...,\tilde{c}_{ij}^K\right)\\&=\Delta\left[\sum_{k=1}^K\lambda_k\Delta^{-1}\left(sa_{ij}^k,0\right),\sum_{k=1}^K\lambda_k\Delta^{-1}\left(ta_{ij}^k,0\right)\right]\\&i=1,2,...,m,\quad j=1,2,...,n\end{aligned}\tag{9}$$

Where, λ_k ($\lambda_k>0$, $\sum_{k=1}^K\lambda_k=1$, $k=1,2,...,K$) is the weight assigned to each appraiser E_k ($k=1,2,...,K$)

3.5. Determination of the competencies that require a training

To determine the competencies that require a training, the appraisers are asked to assess the level of competencies required by the environmental coordinators' position. To achieve that, the appraisers are using the linguistic term set *S*. Their assessments are then converted into interval 2-tuple linguistic variables as explained in section I-D. The interval 2-tuple linguistic assessment matrix corresponding to the required level is defined as $\tilde{R}_k=\left(\tilde{r}_j^k\right)_{1\times n}=\left(\left[\left(sr_j^k,0\right),\left(tr_j^k,0\right)\right]\right)_{1\times n}$, where $\tilde{r}_j^k$ is the interval 2-tuple value related to the linguistic information provided by E_k $(k=1,2,...,K)$ on the assessment of the competency $P_j\,(j=1,2,...,n)$ required by the environmental coordinators position; $sr_j^k,tr_j^k\in S$ and $sr_j^k\le tr_j^k$ $j=1,2,...,n$ $k=1,2,...,K$. These values are then aggregated to form the collective interval 2-tuple linguistic assessment matrix $\tilde{R}=\left(\tilde{r}_j\right)_{1\times n}$, where,

$$\begin{aligned}\tilde{r}_j&=\left[\left(sr_j,\alpha r_j\right),\left(tr_j,\varepsilon r_j\right)\right]=\mathrm{IVTWA}\left(\tilde{r}_j^1,\tilde{r}_j^2,...,\tilde{r}_j^K\right)\\&=\Delta\left[\sum_{k=1}^K\lambda_k\Delta^{-1}\left(sr_j^k,0\right),\sum_{k=1}^K\lambda_k\Delta^{-1}\left(tr_j^k,0\right)\right]\\&j=1,2,...,n\end{aligned}\tag{10}$$

The next step is to compute the gap between the acquired and required level of competencies. To this end, the distance defined by equation (7) is used, which can be written as given in equation (11).

$$\begin{aligned}&d_{ITD}(\tilde{c}_{ij},\tilde{r}_j)=\Delta\left[\frac{1}{2}\left(\left|\Delta^{-1}\left(sa_{ij},\alpha a_{ij}\right)-\Delta^{-1}\left(sr_j,\alpha r_j\right)\right|+\left|\Delta^{-1}\left(ta_{ij},\varepsilon a_{ij}\right)-\Delta^{-1}\left(tr_j,\varepsilon r_j\right)\right|\right)\right]\\&i=1,2,...,m,\quad j=1,2,...,n\end{aligned}\tag{11}$$

The greater the distance, the greater the gap between the acquired and required level. Consequently, the organization should address these gaps by implementing appropriate actions as training to acquire the necessary competencies.

4. Case study

A case study was undertaken to test the validity of the adopted competency assessment approach. It was conducted with professionals following a continuous training at the engineering National School of Applied Sciences situated in Tangier-Morocco. These professionals have different profiles and work in multiple business lines as automotive and Natural gas transportation by pipeline. The program of the training includes a course about sustainable development and ISO 14001:2015 standard. This course initiates these professionals to the environmental coordinators job, and allows them develop many competencies such as waste management, energy efficiency and iso 14001:2015 standard requirements. Towards the end of the course, we proposed to these professionals to take part in a game session and 12 people accepted to participate. We preferred to carry out the session face-to-face in order to be able to evaluate the competencies related to the know-whom category. Furthermore, two appraisers accepted to participate to the EnviRun game session. In agreement with the appraisers, five competencies were selected for the assessment process, P_1: To know the requirements of the ISO 14001:2015 standard, P_2: To know-how to manage solid wastes, P_3: To know-how to work in team, P_4: To know-how to implement energy efficiency measures, and P_5: To know the environmental regulations.

During the game session, the facilitator asked the participants to get into groups of 3 people, in order to observe their team spirit. Furthermore, the facilitator explains the game rules. The teams then, took turns rolling their dice and answering the situations or questions related to the topic in which their counters were placed. Meanwhile, the appraisers were given the assessment grid that includes the five competencies, the name of all the participants, and the assessment scale S={s_0=Extremely Low (EL), s_1= Very Low (VL), s_2= Low (L), s_3= Medium (M), s_4= High (H), s_5= Very High (VH), s_6= Extremely High (EH)}. The appraisers could either chose an interval value to assess a given competency as (VH-EH), or a single value as (L). Table 2 shows the assessments given by the appraisers.

Table 2: Assessments of the competencies acquired by the participants

Appraisers	Participants	Competencies				
		P1	P2	P3	P4	P5
E1	A1	L-M	H-VH	VH	L-M	L
	A2	L-M	M-H	M-H	M-H	L
	A3	M-H	H-VH	H-VH	M	L-M
	A4	M-H	H-VH	H-VH	M	M-H
	A5	L-M	M-H	M-H	M-H	L
	A6	L-M	M-H	M-H	M-H	L
	A7	H- VH	H-VH	VH	H-VH	M
	A8	M-H	H-VH	M-VH	L-M	L-M
	A9	L-M	M-H	M	L	L
	A10	M-H	H-VH	VH	M-H	M-H
	A11	H-VH	M-H	M-H	M-H	L-M
	A12	H-VH	H-VH	VH	H-VH	M-H
E2	A1	M	VH	H-VH	VL-L	L-M
	A2	M	M	M	M	L-M
	A3	H	VH	H-VH	M	M
	A4	H	VH	H-VH	M-H	M
	A5	L	H	M	M	VL-L
	A6	L	H	M	M	L
	A7	VH	VH	VH-EH	VH	M-H
	A8	H	H-VH	H-VH	M	M
	A9	M	H	M-H	L	L-M
	A10	M	VH	EH	H	H
	A11	VH-EH	H	H	H	M
	A12	VH	H	H-VH	VH	H

At the end of the game, the assessment grids were gathered, and the results were analyzed. To achieve that, the assessments given by the appraisers were converted into interval 2-tuple variables to form the interval 2-tuple linguistic assessment matrix.

As explained in the previous section, a rating such as M can be written as $\left[(s_3,0),(s_3,0)\right]$, and a grade such as H-VH can be written as $\left[(s_4,0),(s_5,0)\right]$. Thereafter, these assessments of the competencies level acquired by the participants are aggregated to form a collective interval 2-tuple linguistic assessment matrix., as given in equation (9) The same weight was assigned to all the appraisers. Table 3 summarizes the aggregated values.

Table 3: The aggregated acquired competencies interval 2-tuple values

Participants	Competencies				
	P1	P2	P3	P4	P5
A1	Δ(0.417, 0.500)	Δ(0.750, 0.833)	Δ(0.750, 0.833)	Δ(0.250, 0.417)	Δ(0.333, 0.417)
A2	Δ(0.417, 0.500)	Δ(0.500, 0.583)	Δ(0.500, 0.583)	Δ(0.500, 0.583)	Δ(0.333, 0.417)
A3	Δ(0.583, 0.667)	Δ(0.750, 0.833)	Δ(0.667, 0.833)	Δ(0.500, 0.500)	Δ(0.417, 0.500)
A4	Δ(0.583, 0.667)	Δ(0.750, 0.833)	Δ(0.667, 0.833)	Δ(0.500, 0.583)	Δ(0.500, 0.583)
A5	Δ(0.333, 0.417)	Δ(0.583, 0.667)	Δ(0.500, 0.583)	Δ(0.500, 0.583)	Δ(0.250, 0.333)
A6	Δ(0.333, 0.417)	Δ(0.583, 0.667)	Δ(0.500, 0.583)	Δ(0.500, 0.583)	Δ(0.333, 0.333)
A7	Δ(0.750, 0.833)	Δ(0.750, 0.833)	Δ(0.833, 0.917)	Δ(0.750, 0.833)	Δ(0.500, 0.583)
A8	Δ(0.583, 0.667)	Δ(0.667, 0.833)	Δ(0.583, 0.750)	Δ(0.417, 0.500)	Δ(0.417, 0.500)
A9	Δ(0.417, 0.500)	Δ(0.583, 0.667)	Δ(0.500, 0.583)	Δ(0.333, 0.333)	Δ(0.333, 0.417)
A10	Δ(0.500, 0.583)	Δ(0.750, 0.833)	Δ(0.917, 0.917)	Δ(0.583, 0.667)	Δ(0.583, 0.667)
A11	Δ(0.750, 0.917)	Δ(0.583, 0.667)	Δ(0.583, 0.667)	Δ(0.583, 0.667)	Δ(0.417, 0.500)
A12	Δ(0.750, 0.833)	Δ(0.667, 0.750)	Δ(0.750, 0.833)	Δ(0.750, 0.833)	Δ(0.583, 0.667)

Regarding the required level, the appraisers assigned the value Extremely High (EH) to the five competencies. Accordingly, and by reference to equation (11) the distance between the acquired and required competencies level was computed. The results are presented in Table 4.

Table 4: The distance between the acquired and required competencies level

Participants	**Competencies**				
	P_1	P_2	P_3	P_4	P_5
A1	Δ(0,542)	Δ(0,208)	Δ(0,208)	Δ(0,667)	Δ(0,625)
A2	Δ(0,542)	Δ(0,458)	Δ(0,458)	Δ(0,458)	Δ(0,625)
A3	Δ(0,375)	Δ(0,208)	Δ(0,250)	Δ(0,500)	Δ(0,542)
A4	Δ(0,375)	Δ(0,208)	Δ(0,250)	Δ(0,458)	Δ(0,458)
A_5	Δ(0,625)	Δ(0,375)	Δ(0,458)	Δ(0,458)	Δ(0,708)
A_6	Δ(0,625)	Δ(0,375)	Δ(0,458)	Δ(0,458)	Δ(0,667)
A_7	Δ(0,208)	Δ(0,208)	Δ(0,125)	Δ(0,208)	Δ(0,458)
A_8	Δ(0,375)	Δ(0,250)	Δ(0,333)	Δ(0,542)	Δ(0,542)
A_9	Δ(0,542)	Δ(0,375)	Δ(0,458)	Δ(0,667)	Δ(0,625)
A_{10}	Δ(0,458)	Δ(0,208)	Δ(0,083)	Δ(0,375)	Δ(0,375)
A_{11}	Δ(0,167)	Δ(0,375)	Δ(0,375)	Δ(0,375)	Δ(0,542)
A_{12}	Δ(0,208)	Δ(0,292)	Δ(0,208)	Δ(0,208)	Δ(0,375)

The greater the distance, the greater the gap between the acquired and required level. As it can be noticed in Table 4, a color code has been set up. In fact, the green color corresponds to a distance between the acquired and required level less than or equal to Low (L). Consequently, no training is required. The orange color is related to a distance that lays between Low (L) and Medium (M). In this case, the participant must invest a greater personal effort to acquire a good competency level. The red color signifies that the distance between the acquired and required level is strictly greater than or equal to High (H). It also means that the participant needs to undertake a deeper training.

The results show that most of the game participants demonstrate a good competency level in the case of these competencies “To know-how to manage solid wastes”, and “To know-how to work in team”. Furthermore, we can deduce that the participants (A_1, A_9) and (A_5, A_6) need further trainings respectively in the competencies “To know-how to implement energy efficiency measures” and “To know the environmental regulations”. Regarding the competencies “To know the requirements of the ISO 14001:2015 standard” and “To know the environmental regulations”, most of the participants have to deepen their competencies. Moreover, it can be noticed that the participants A_7 and A_{12} have a good level in almost all the competencies.

The game-based competency assessment is a new concept that has received very positive feedback from professionals who prefer to participate in the game session instead of taking a test or an interview. In fact, the proposed competency assessment approach is more reliable because it offers a pleasant and relaxed atmosphere that allows the professionals to show their full potential. Therefore, using serious games for competency assessment purposes can be a major asset in the industrial sector. It is true that EnviRun is dedicated to environmental competencies. However, the concept can be generalized to other fields.

5. Conclusions

The study undertaken in this article has allowed us to show that a new method of assessing competencies through a serious game is effective. Indeed, the participants took a lot of pleasure in participating in the game, which allowed them to show all their potential while having fun. Moreover, thanks to the EnviRun serious game, they were able to develop new skills, since the serious game is also a learning mean. One of the limitations of the proposed approach is that it does not allow to know which of the participants is the most suitable for the environmental coordinator. To overcame this limitation, a multi-criteria decision-making method can be combined with the assessment approach. This will be the subject of our future works.

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