Providing Distance Education on Sustainability Management for Brazilian Research Professionals

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Abstract: The adoption of distance education has become increasingly critical in addressing global education demands. Therefore, this paper explores the design, implementation, and outcomes of the "Sustainable Development Basics" online course developed in 2024 for the SENAI (Serviço Nacional de Aprendizagem Industrial which translates to "National Service for Industrial Training") Innovation Institutes (ISIs) located in Brazil. Targeted at researchers, the course is part of the "Sustainability Management" training track, which is embedded in an applied research management training program based on the ISI core processes. Moreover, the course content was incorporated into the online platform of the Corporate University of the Industry System, which is organized and run by the Brazilian National Confederation of Industry. The course structure entails a range of didactic elements, including guided self-study modules, practical exercises and assessment quizzes. These modules are designed to provide a comprehensive understanding of sustainability principles, strategies, and frameworks, with a focus on real-world applications within industrial and research environments. The course covers key topics such as sustainability in the industry, sustainability management in Research & Technology Organizations (RTOs) and sustainability reporting standards. A notable aspect of the course and contribution to the field of distance education is the combination of learning resources such as videos and presentations with self-study exercises and quizzes to reinforce learning outcomes. Further, the distinct framing and application of learning objectives play a vital role in the facilitation of the course. This paper provides best practices for course design, discusses distinct challenges and feedback gathered by participants. Furthermore, it highlights implications for managers aiming to adopt similar distance education initiatives and underscores the importance of combining synchronous and asynchronous education methods. The paper outlines future research opportunities in distance education, namely the exploration of adaptive learning technologies and the cross-cultural applicability of course content. Our findings underscore the importance of aligning the course content with relevant industry and research challenges and leveraging digital platforms to create flexible, impactful learning experiences. Furthermore, these findings contribute to advancing the field of distance education and provide actionable guidance for practitioners aiming to address sustainability through innovative education solutions.

Keywords: Distance Education, Sustainability Management, Professional Education, Brazil, Research & Technology Organizations

1. Introduction

Due to the effects of the COVID-19 pandemic, distance education gained substantial traction in the education system both for professionals and students (Pregowska et al. (2021). During this time, physical presence for education purposes was limited in many countries due to government regulations, leading to a surge in the usage of online education tools. However, the technologies developed during this timeframe are still relevant today and are implemented worldwide (Garlinska et al. (2023). Particularly in the professional education sector, online learning programs, webinars and video recordings are continuously offered. In the case of Brazil, distance education for professionals provides the possibility to interact with experts from abroad and tap into unique knowledge assets. SENAI is in charge of coordinating 28 Innovation Institutes is one of the main providers of education in Brazil. The ISIs have been established in close cooperation with the Fraunhofer Institute for Production Systems and Design Technology (IPK) and serve as national innovation hubs, aiming to strengthen the competitiveness of the Brazilian industries through applied research and advance technological solutions (Will et al. (2020). In consultation between the two entities, it was established that a crucial area in which the researchers of the ISIs could benefit from an increase in their knowledge stock is the topic of sustainability. This is due to an increased focus of the Brazilian national government on this topic and heightened global industry demands relating to sustainable technologies (Prá Carvalho, Dalarosa & Zarelli. (2018; Udemba & Tosun. (2022;

Gramkow & Anger-Kraavi. (2018; Maçaneiro, Da Cunha & Balbinot. (2013). Therefore, Fraunhofer IPK created a "Sustainability Management" training track, that is part of a wider applied research management program and entails an online training course aiming to familiarize especially junior ISI researchers with the basics of sustainability management relevant in the context of an RTO. Hence, this paper will first delve into the relevant literature related to the field of distance education. Following the "Applied Research Management Program" will be introduced and subsequently the design and content of the "Sustainability Training Track" will be highlighted, with specific emphasis placed on the "Sustainability Basics Course". Subsequently, the feedback of the course participants will be discussed and recommendations for managers and researchers provided.

2. Literature Review

In this literature review the origin of distance education and its current status will be discussed. Further, the importance of distance education in Brazil and for the ISIs will be highlighted. Concluding the section, the best practices and challenges in the domain of distance education will be illustrated.

2.1 Distance Education and Learning

The first form of distance education was recorded in 1728 in the United States of America where the teacher Caleb Philip provided the opportunity to study material and lessons via mail (Katane & Katans. (2015). Over the following decades the concept of distance education became increasingly popular for universities worldwide, reaching its peak during the COVID-19 pandemic (Zawacki-Richter. (2023). Due to technological advancement and societal changes, the definition of distance education has shifted over the years. Hence, this paper implies a more recent definition and follows (Saykili. (2018) who defines distance education as "a form of education which brings together the physically-distant learner(s) and the facilitator(s) of the learning activity around planned and structured learning experiences via various two or multi-way mediated media channels that allow interactions between/among learners and facilitators as well as between learners and educational resources." Further, distance education can be classified into two separate delivery methods: asynchronous and synchronous methods (Koehler & Blair. (2003). Hereby, both approaches are learner-centred, but while asynchronous methods emphasize the availability of education content at all times, such as recorded lectures, synchronous methods focus on real-time interaction between the learner and the educator in, for example, live online classes (Shahabadi & Uplane. (2015).

2.2 Distance Education in Brazil

In Brazil, the first forms of distance education were introduced in the late 19th century while the concept was only officially established in 1996 by the National Educational Law of Policies and Bases (Baxto, Amaro & Mattar. (2019). Over the last decades distance education has increased in popularity in Brazil particularly higher education institutions. Considering the geography of Brazil, distance education enables the distribution of knowledge into various and remote regions of the country (Baxto, Amaro & Mattar. (2019). Moreover, distance education for professionals offers a valuable opportunity for the country's workforce, which has to an extent been utilized by companies through the creation of corporate universities (Porto & Berge. (2008). The authors argue that these institutions offer distance education to employees on a variety of topics through customized learning content. To generate such content, third-party organizations are often employed or educational content from expert institutions is utilized (Porto & Berge. (2008). Typically, companies undertake the effort to create a corporate university to continually increase the skills and knowledge of the workforce and thus increase their competitiveness. SENAI and the ISIs also utilize the services of a corporate university, namely the Corporate University of the Industry System, which was created by the Brazilian national confederation of industry. It has been established in 2013 and aims to enhance the strategic skills and competencies of employees within industry system, specifically the National Industry Confederation, Industrial Social Service, and state-level industry federations across Brazil through a wide offer of courses and training programs.

2.3 Challenges and Best Practice in Distance Education

To facilitate high quality and effective distance learning content, the environment of the recipients needs to first be analysed. This holds particularly true for distance education programs in emerging economies such as Brazil, where the concept of distance education is not well established, bureaucracy is not always operating efficiently and the necessary technological tools are not widely available (Baxto, Amaro & Mattar. (2019; Barikzai, Bharathi S & Perdana. (2024). Further, experiences from previous distance education programs need to be analysed

(Geçer, Bagci & Atar. (2023; dela Peña Bandalaria. (2023). When creating the structure and content of a distance education program, various aspects need to be taken into consideration. This is particularly important to overcome challenges in distance education such as lack of self-discipline, low motivation, non-frequent feedback, indefinite content and time constraints due to employment responsibilities (Geçer, Bagci & Atar. (2023; Yaw Koi-Akrofi, Owusu-Oware & Tanye. (2020). For a successful distance education programme, a structured curriculum should be developed that follows a logical sequence and contains a comprehensive description of the planned content (Khan et al. (2017; Singer-Coudoux, Buxmann & Will. (2024). Further, when creating the educational content, the selection of suitable teaching materials is crucial (Adalikwu & Iorkpilgh. (2013). Empirical studies show that video-based learning is often considered best practice in distance education (Yousef, Chatti & Schroeder. (2014). This approach should be complemented by self-study units that allow participants to engage deeply with the material and improve their critical thinking skills (Lim et al. (2024; Turan & Koç. (2018). Further, the use of short-format instructional videos is particularly beneficial for distance education (Laparra et al. (2023; Sitzmann & Ely. (2011; Yousef, Chatti & Schroeder. (2014). The presentation of the content should begin with a convincing introductory text for each learning unit and contain clearly defined learning objectives (Martin & Bolliger. (2022). The objectives must be specifically tailored to the virtual learning environment, should address the audience, entail an action verb that describes the desired behaviour that the learner is able to display after the training and to which standard, and lastly point out under which conditions the behaviour should be exhibited (I-Tech. (2010). Further, the objectives should reflect what kind of cognitive processes are expected to be displayed by the learner, these range from listing learned facts to synthesize and assess the learned content. Hence good learning objectives set realistic expectations and enable an effective assessment. To ensure active engagement with the material, learning success should be monitored through assessment mechanisms such as quizzes and interactive exercises (Khan et al. (2017). To maintain motivation and maximize learner engagement, it is also recommended to offer certification upon completion of the course (Cumberland, Petrosko & Jones. (2018).

3. The Applied Research Management Training Program

Fraunhofer IPK and SENAI have a long-reaching history of cooperation. For example, the Fraunhofer IPK, was heavily involved in the creation of the ISI Network, which now acts as an important pillar of the Brazilian innovation system (Will et al. (2020). In total there are currently 28 ISIs that focus on applied research in various areas, including laser processing, advance health systems or biosynthetics. Together these two entities structured the ISI core processes, which are namely: Strategic Management, Marketing & Sales, Applied Research & Development / Innovation and Project Management & Service Delivery. These core processes constitute the activities that, if executed properly by an ISI, generate value. Hence, these processes are vital to the work of ISI researchers and inspired the creation of the “Applied Research Management” training program. The program is based on these processes and targets ISI researchers. Each of these core processes acts as a section of the training program and contains training on topics related to these processes. Three training courses are conceptualized per topic with varying complexity levels, namely basic, advanced and expert. The training courses follow either asynchronous or synchronous delivery methods. In figure 1 the training topics of the ISI core process of strategic management are depicted. The highlighted topic of “Sustainability Management” entails the course “Sustainable Development Basics”, which will be discussed in more detail in the following chapters.

Figure 1: Excerpt of the Applied Research Manager Program

3.1 Design of the Training Track for Sustainability Management

The topic of sustainability has been identified by SENAI as a crucial area for the competitiveness and innovation capability of the ISIs. Hence, one of the main objectives of the cooperation between SENAI and Fraunhofer IPK was to create training content for ISI researchers that addresses the topic effectively and takes into consideration their positions within the institutes. Here, the training track "Sustainability Management" aims to contribute to two objectives: First, to strengthen SENAI's strategic organizational competence in sustainability management and enhance the ISI Network's competitiveness. Second, to empower ISI researchers to integrate sustainability concepts into their research activities. The training track encompasses three different courses with varying skill levels and guide researchers through sustainability concepts and assessments. The first course, "Sustainable Development Basics", requires approximately four and a half hours of learning time. It is delivered on the online platform of the Corporate University of the Industry System and consists of a mix of web-based trainings and self-study sessions. It introduces basic but key sustainability concepts. By correctly answering a quiz the learner can advance within the course. The main objectives of this course are to explore the current trends of sustainability in the industry and in research institutes, highlighting concepts and strategies of sustainability management and to dive into practical examples of sustainability programs and actions. Upon completing the first course, participants can apply for the course "R&D Project Impact Assessment. This course has a duration of 8 hours and is delivered through live online sessions and exercises over three days. The focus is on assessing the sustainability impact of R&D projects. Participants engage in discussions, peer reviews and interactive exercises, leading to a plenary session where they present their results. The main objectives of this course are to equip researchers with the ability to measure and demonstrate their contributions to the Sustainable Development Goals (SDGs) and assess the sustainable impact of their R&D projects. The final course, "Planning Collaborative R&D Impact", has a duration of 16 hours. Conducted as a two-day onsite training in Brazil, it emphasizes collaborative ideation of R&D projects with a positive impact on sustainability aspects. Participants work together in groups, receive coaching and refine their project proposals. The main objectives of this course are to enable researchers to plan their R&D project's sustainability impact in advance and enhance their ability to set their project proposals apart from competitors. Each course builds upon the previous one, ensuring a progressive learning path that allows researchers to develop a deep understanding of sustainability in R&D.

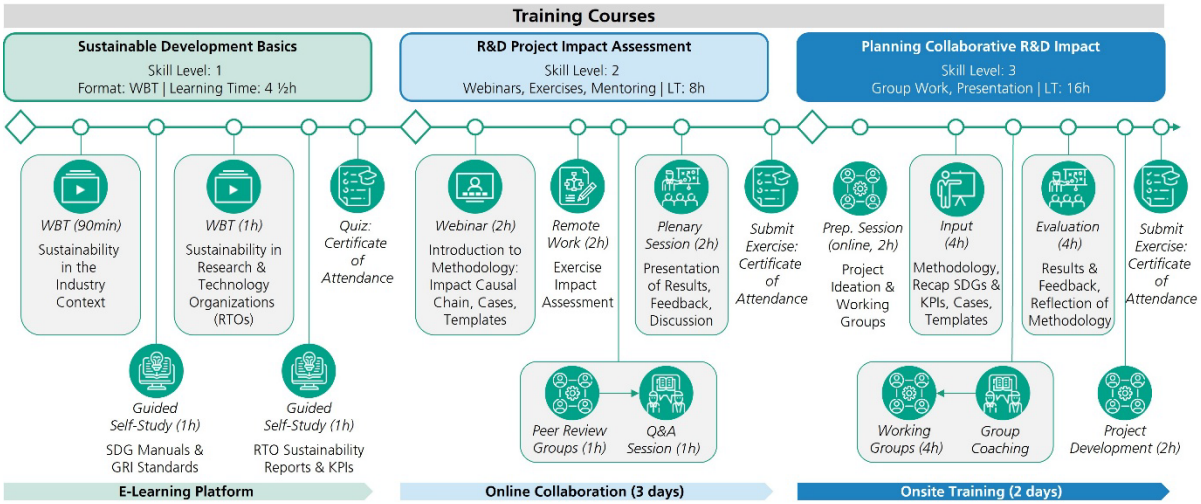

Figure 2: Structure of the Training Track for Sustainability Management

4. Configuration of the Sustainable Development Basics Course

For the creation of the course "Sustainable Development Basics", the Fraunhofer IPK team took inspiration from best practice examples highlighted in chapter 2.2. The target audience of the course are ISI researchers that are at the beginning of their careers and are aiming to increase their knowledge on sustainability. The delivery method of the course is asynchronous. This method was chosen to scale the accessibility of the content and thus allowing numerous researchers to engage with the material at their own pace. The overall course structure is depicted in figure 3 and based on a modular approach, consisting of six modules with a total estimated learning time of 4 1/2 hours. These modules cover different aspects of sustainability and are designed to provide a progressive learning experience. These were integrated in the platform of the Corporate University of the

Industry System and can be separated into different categories: Web-Based Training (WBT) or self-study modules. In WBT modules, a pre-recorded video with an average length of 20 minutes is available for the learner to engage with. In the self-study modules, various documents are provided that the learner should interact with in the timeframe of an hour. Each module begins with an introduction text that highlights the content of the module and its learning objectives. Hereby each module contains three learning objectives that gradually increase in the complexity of the cognitive processes that the learner should be able to demonstrate after finishing the module. If the module contains a video, a CV of the speaker is also provided to the learner as well as the presentation shown in the video. If the module is a self-study session, the learner is provided with documents that relate to the course and instructions on how to interact with the material. In the modules 2, 3, 4 and 5, quiz questions related to their content are provided. The learner is required to answer 80% of the quiz questions correctly to be able to start the next module. This process was integrated to control for the learner's engagement with the content of the modules. After the successful completion of module 6 and thereby the completion of the course, the learner gets provided a certificate of successful completion. This approach was used to strengthen the motivation of participants and provide a documentation of their participation, which in the corporate context can be used for further career development.

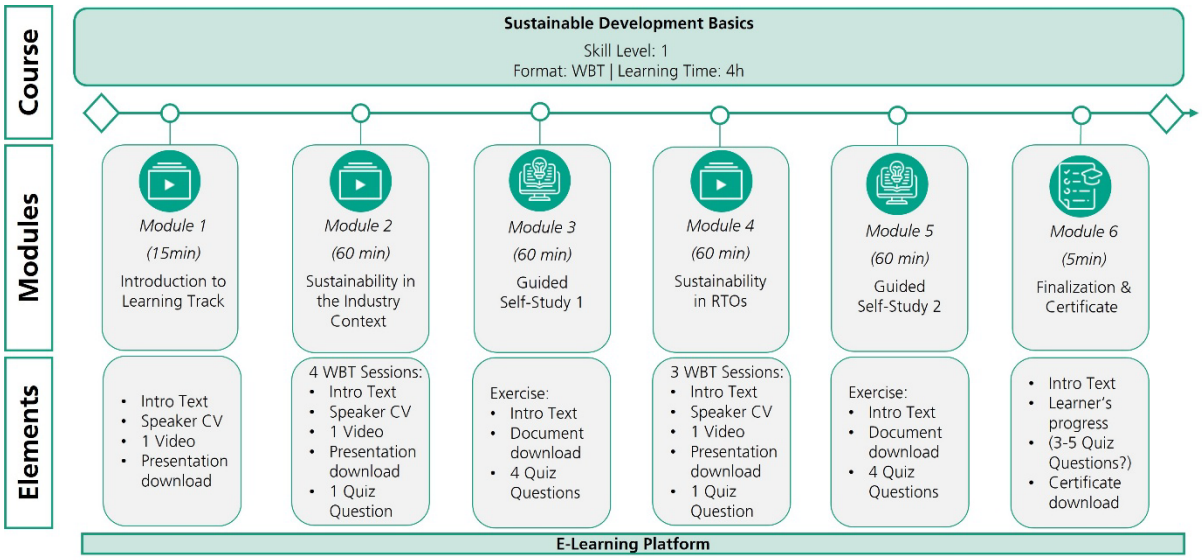

Figure 3: Structure of the Sustainable Development Basics course

5. Content of the Sustainable Development Basics Course

The "Sustainable Development Basics" course aims to provide ISI researchers with a rudimentary overview of the concepts related to sustainability in the industry as well as for RTOs. Module 1 entails an introduction to the course, track and overall training program. It highlights changes to previous training courses and lays out the structure and focus of the following modules. Module 2 consists of four videos that focus on the topic of sustainability in the industry context. In the first video the concept of sustainability and the SDGs are illustrated. Following, various sustainability initiatives, regulations and standards are introduced. Here a specific focus is put on the Brazilian economy. Subsequently, the steps to create a robust company strategy on sustainability are outlined and methods to counteract pressing environmental challenges are presented. Lastly, best practice related to the different dimensions of sustainability are presented and strategies for RTOs to support small and medium enterprises in sustainability actions are provided. Module 3 constitutes the first of two self-study sessions. In Module 3 the focus lies on the SDGs. The learners are provided with two documents to read, namely the "SDG Compass" and "A short introduction to the GRI Standards". The learners are asked to contemplate how sustainability reporting can be made attractive to potential RTO customers. Following, Module 4 contains two videos that focus on the RTO perspective in the context of sustainability. The first video highlights the drivers of sustainability for RTOs. Hereby, different impact perspectives are explained and sustainability actions by various RTOs presented. In the last video, the topic of assessing the sustainability impact of R&D activities from RTOs is introduced. Further best practices examples for the communication of positive sustainability impact are given. Module 5 is the second self-study session and focuses on the sustainability report of the Fraunhofer-Gesellschaft. Learners should focus on the integration of sustainability in the work of researchers and the Fraunhofer-Gesellschaft governance structure. They should also theorize about possible sustainability actions

that their RTO could engage in. Finally, Module 6 presents the learners with a final quiz relating to the content of the previous modules. Once correctly answered the learners can download their participation certificate.

5.1 Implementation of the Sustainable Development Basics Course

The implementation process of the ”Sustainable Development Basics” course on the platform of the Corporate University of the Industry System was carried out by researchers of Fraunhofer IPK, SENAI National Department (DN) experts and professionals from the Corporate University itself. Fraunhofer IPK provided the produced course material to the Corporate University of the Industry System, who were responsible for the structuring and integration of the material into the platform. Therefore, an authoring tool designed for creating educational content was utilized. Hereby, the content was generated in using the Sharable Content Object Reference Model (SCORM) format, ensuring compatibility with the virtual learning environment. Following, the created course was tested by SENAI DN experts and Fraunhofer IPK researchers to assure a well-functioning training process and report potential flaws. Before opening the course to potential learners, they were informed via E-Mail that a new course has been created and what topics will be covered by it. A 30-minute webinar was also provided in which a Fraunhofer expert introduced the course concept, content and benefits. These activities were carried out to promote the “Sustainable Development Basics” course, raise interest and increase the participation numbers. The course was officially launched in September 2024.

6. Feedback for the Sustainable Development Basics Course

The following section presents an analysis of the course evaluation that was conducted in January 2025. Out of 50 individuals who started the course, 28 completed the full program and provided feedback. Participants rated their level of satisfaction/agreement with the following questions/statements using a five-point Likert scale. Notably, 100% of these participants expressed overall approval of the course. Figure 4 shows that 96 % of participants were satisfied or very satisfied with the course, highlighting its effective design. This high satisfaction reflects the successful alignment of content, format, and workload with participants’ professional routines.

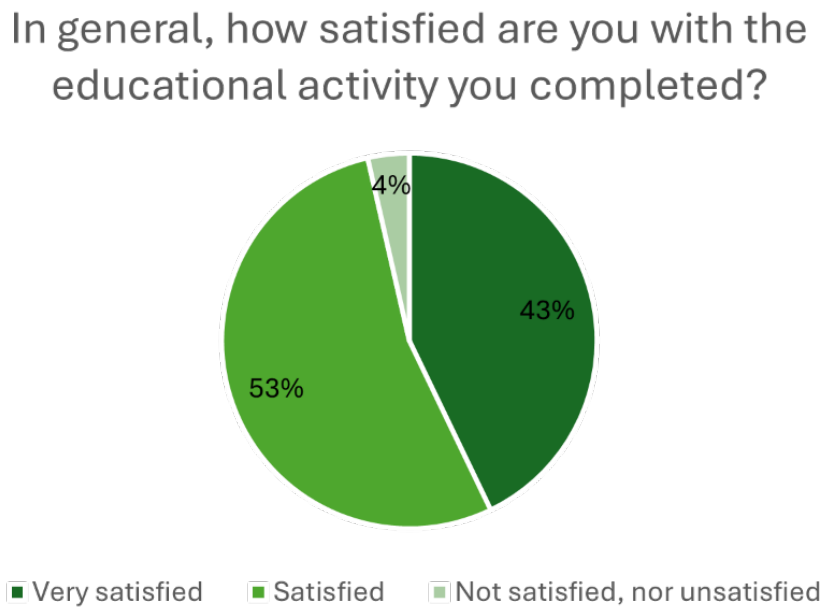

Figure 4: Level of overall Satisfaction

Figure 5 shows that 96 % of participants agreed or strongly agreed that the course content contributed to their professional development. This result emphasizes the course’s practical relevance and its effectiveness in addressing the specific needs of professionals working in research and industrial settings.

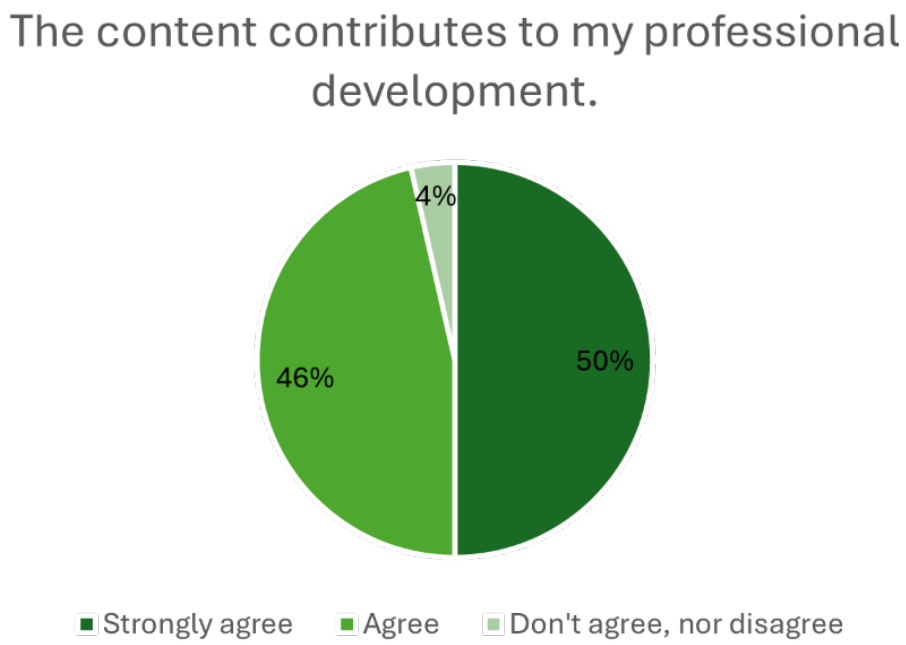

Figure 5: Contribution to professional development

Figure 6 illustrates participants' satisfaction with the educational workload. This aspect is particularly significant given that the course was conducted in a standard workplace setting alongside participants' regular professional duties, a critical consideration in the course's design. Notably, 27 out of 28 participants (96 %) agreed that the educational workload was appropriate, indicating a high level of alignment between course demands and the realities of workplace-based learning.

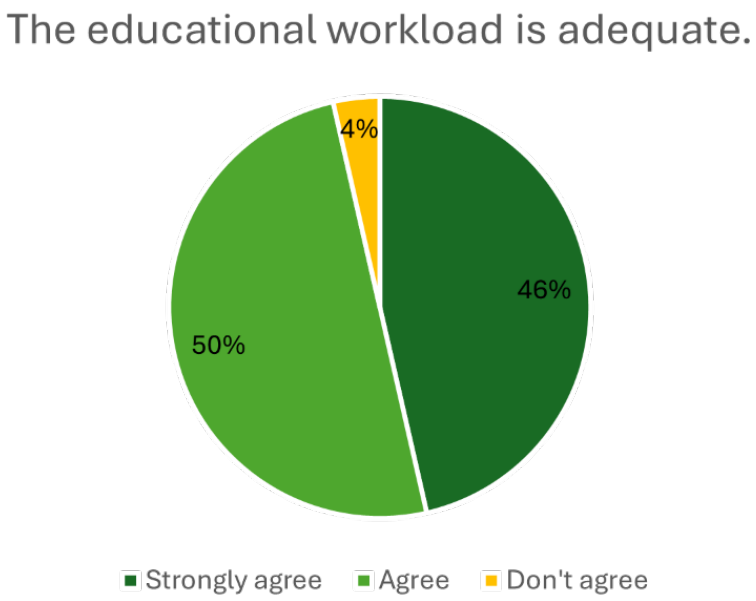

Figure 6: Adequateness of workload

The overall feedback reflects a high level of satisfaction with the course. However, several participants expressed a desire for enhanced interaction, specifically through direct engagement with instructors in synchronous sessions. Additionally, there was a clear interest in expanding course content to address contemporary topics such as artificial intelligence. One participant also suggested that the inclusion of case studies tailored to the organizational context could significantly enhance comprehension, noting: *"I believe that the implementation of case studies applied to our system would facilitate understanding."* In addition, the need for technical depth was highlighted, with one participant stating: *"More technical segmentations, we have seen many actions done by*

Fraunhofer and I would like to apply in a more technical way in my ISI." The feedback points to participants' interest in more interactive, technically focused content that reflects current industry and research challenges.

7. Discussion and Conclusion

The very high satisfaction rate of course participants highlights the success of our modular asynchronous distance education approach tailored to RTO professionals. Further, a key success factor of the course was the alignment with the workplace realities of RTO professionals in Brazil which is highlighted by the positive feedback related to flexibility, manageable workload and practical relevance. Hence, these results underline the method of building the course on best practice processes. Particularly, the structural design, length and content relevancy for the target audience of the course played an important role in the positive feedback. However, it needs to be pointed out that there are areas for improvement derived from the participant feedback. Most notably is the integration of synchronous elements such as Q&A sessions or webinars that foster the engagement between learners and instructors. Moreover, the integration of learner related case studies and more technical content highlight an avenue for specialising course content. Future iterations of the distance education course should integrate such specializations and operate a hybrid model that combines synchronous and asynchronous elements. The courses' success provides guidance for managers and distance education instructors that aim to facilitate learning content for professionals. Emphasis should be placed on understanding the needs of the target audience and address real-world challenges. Further, structuring the content in different modules that consist of short video sessions or self-study material that can be accessed in a flexible manner can have a positive influence on the success of the distance education program. Enabling learners to engage directly with the instructors via, for example, Q&A sessions, provides an opportunity to increase motivation and resolve pending questions. Lastly, future research could focus on the exploration of adaptive learning technologies like AI and the cross-cultural applicability of course content.

Ethical Declaration

This research did not require ethical clearance, as it does not involve procedures requiring prior approval from an ethics committee.

AI Declaration

For the creation of this paper no AI tools were used.

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