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iJET International Journal of Emerging Technologies in Learning

iJET | eISSN: 1863-0383 | Vol. 18 No. 14 (2023) | OPEN ACCESS

https://doi.org/10.3991/ijet.v18i14.38385

PAPER

Overcoming Integration Thresholds for Augmented Reality

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ABSTRACT

The advent of augmented reality (AR) is reshaping the way people experience physical and virtual environments, from observation to immersion. Growing interest in adopting AR provides opportunities for immersive learning, upskilling, and renewal. However, uncertainties exist in how to maneuver a transition toward making use of this technology through systematic integration. Due to the turmoil caused by the global pandemic health crisis, implementation of AR now faces urgency in minimizing adoption thresholds and establishing a more systematic escalation approach. This paper investigates the characteristics of such learning approaches and examines the integration of AR with customized progression. Two solution suppliers were investigated to uncover the integration process of AR, which, to the best of our knowledge, is scarcely explored in existing research. This study reveals that a balanced escalation of user-centric learning activities, i.e., an onboarding process, harmonizes anticipated cognition levels for a designated AR application tool.

KEYWORDS

augmented reality, onboarding, learning, technology provider

1 INTRODUCTION

The constraints imposed during the pandemic and the increasing influence of digitalization have made organizations more compelled to change and adapt. In the context of the Fourth Industrial Revolution, emerging technologies have assumed a crucial role for organizations to pursue innovation and thrive [1, 2]. These technologies have significant strategic implications for operational processes and offer avenues for advancement. The challenge of dealing with uncertainty in emerging technologies is often overwhelming due to limited testing in operating environments, which leaves several design aspects unknown [3, 4].

Ambitions for sustainability and resilience in the post-pandemic era have led to a heightened focus on leveraging emerging technologies, including extended reality (XR) [5, 6]. XR is used as an umbrella term, encompassing augmented reality (AR),

Berglund, A. (2023). Overcoming Integration Thresholds for Augmented Reality. *International Journal of Emerging Technologies in Learning (iJET)*, 18(14), pp. 51–65. https://doi.org/10.3991/ijet.v18i14.38385

Article submitted 2023-01-26. Resubmitted 2023-04-03. Final acceptance 2023-04-06. Final version published as submitted by the authors.

mixed reality (MR), and virtual reality (VR). The differences among the realities are that AR superimposes virtual and real objects in a real-time display, MR consists of high-fidelity holographic 3D models integrated into the real world, and VR allows users to control and navigate their movements in a simulated real or imagined world [2]. AR's most significant advantage is its ability to create immersive hybrid learning environments that combine digital and physical objects, thus making implementation procedures a reason to investigate learning progression [7]. To deepen learning, it is common to involve reflection as part of training sessions to restructure existing knowledge [8]. Based on the opportunity to intensify interaction with AR content, the interaction of subjects has been shown to promote work efficiency and motivation [9]. Levels of activity and independence are also strongly related to the need for special training and study for the development of AR [10]. Learning sessions also imply the use of AR capabilities, where interactive actions are facilitated by the digital environment. For the learner, the virtual and physical environments create an overlap, resulting in a deep sense of presence and interaction [11].

For a myriad of disciplines, such as designers, computer scientists, and engineers, today's technology offers more efficient and practical ways to demonstrate new products and services in their early stages, thus providing room for enriched iteration cycles [12, 13]. Adopting XR, engineers and manufacturers can design experiences and creations before they are built, which can have an impact on strategy and a heightened sense of reality. This supports designers in selecting suitable technological features to stimulate the desired immersion and presence [14]. XR also carries the possibility to discern different effects related to sensory or perceptual stimuli on multiple levels of immersion and presence. However, many companies have not incorporated parts of XR into their organizational systems [15]. With uncertainties in overarching adoption and digitalization processes across different business areas [16], the dilemma of accurately assessing emerging tools has also become a major concern in the field of education [6, 9, 17]. In response to the increased attention on AR technologies and their diverse applications, the number of related publications has escalated in recent years.

Since this paper is focused on the utilization and potential scaling up of AR as a tool, existing research covers several partly overlapping areas, such as manufacturing assembly [18], learning and assessment [19], and challenges for industrial implementation [20]. Notably, AR has witnessed an increase in its application use on shop floors. However, the validation of its impact and value is still pending, which hinders further motivation towards strategic implementation decisions [15]. Another aspect that delays successful implementation attempts is the scarcity of existing research on how AR applications are used and integrated for manufacturing training [21]. In situations where systematic training is needed, more attention should be placed on minimizing learning difficulties between presence and interaction involving the learner and the virtual and physical environments [11, 22]. The advantage of AR lies in its ability to facilitate the development of skills such as critical thinking through interdependent collaborative exercises. This paper presents AR as a comprehensive approach to address diverse needs. Despite the inherent resistance to change among humans, the paper explores ways to systematically lower the adoption thresholds of AR.

2 LITERATURE REVIEW

Several critical aspects of the AR onboarding processes demonstrate strong relevance to essential design characteristics [12, 13], which can be approached from multiple perspectives to provide novel insights into problem framing and solutions:

- Empathy-based approach: Onboarding processes of AR can provide an empathy-based approach to problem framing by understanding the needs and wants of the end-users, which can help to identify and frame the problem in a way that takes into account the users' perspectives.
- Iterative approach: Onboarding processes of AR are often iterative, which means that problem framing and solutions are refined and improved over time as users test and provide feedback on the AR experience. This can lead to new insights and better solutions, as user feedback is taken into account.
- Collaborative approach: Onboarding processes of AR often involve collaboration between different stakeholders, including users, developers, and designers. This enable greater transparency as different perspectives are brought together to frame the problem and develop ideas.
- Hands-on learning: Onboarding processes of AR are often hands-on experiences for users to test the AR technology. This supports reflective practices [8] and enable users to engage with the technology in various real-time settings and provide opportunities for insightful feedback.
- Real-world application: Onboarding processes of AR are often used in real-world scenarios, presenting valuable opportunities to test the technology in authentic settings.
- Experiential learning: Onboarding processes of AR is an experiential learning approach, where learning takes place in real-world scenarios and provides hands-on experience within a safe environment.

In line with a more personalized learning environment, graphics with sophisticated data overlays of rich media are superimposed onto the real world for viewing through web-enabled devices, such as phones, tablets, or more advanced head-mounted devices. The mediating device augments the user's experience by providing access to additional information when and where it is needed. These added layers of information serve as a foundation for easily accessible knowledge-building. While some researchers claim a risk for information overload [20], a contrasting view is that AR helps to reduce cognitive overload by providing targeted depth to vital areas of concern, and that learners can benefit from scaffolding and more easily learn from experiences captured in various contexts and scenarios [23]. Comprehensive learning experiences have been introduced to address immersion and presence as two distinct aspects that contribute to performance and engagement [24]. With rising interest in providing guiding examples, experiences from learning assessment in AR research are establishing a link that may support continued practical implementation efforts [19]. However, there remains a layer of uncertainty involved and a challenge in realistically quantifying the return on investment when preparing for implementation [25]. This limitation in existing competencies also poses difficulties in adoption and systematic integration that can provide for innovation activities and strategic benefits for an organization [26].

2.1 Adoption value of augmented reality

With intensified efforts to cut margins and leverage digitalization for efficient transitions, organizations adopting new technologies such as AR show indications of becoming strong actors in the supply chain as system providers [27]. Another aspect that past literature has brought forward is the consideration for usability and sustainability since the adoption of new technologies may cause ripple effects in other parts of

an organization, thus affecting procedures and domains beyond the immediate scope [5, 28]. The wide range of application areas currently exploring the adoption and utilization of AR presents an array of opportunities to facilitate seamless knowledge acquisition and establishment of new skill sets [17]. Despite the presence of numerous critical challenges, difficulties in overcoming technology thresholds often result in a readiness gap that may prematurely disregard well-intentioned efforts [29]. The industry's weak adoption rate has led to a strong push for technology, where reluctant attempts to incorporate short-sighted solutions create an overwhelming dissonance toward leveraging the potential of AR. However, the apparent limitation in existing AR studies highlights the need for further explorative investigations into the adoption process [30].

2.2 Scaling dilemmas

Scaling up AR across internal business platforms places significant pressure on incorporating input from external parties. External collaborators, including high-end technology suppliers, have become an increasingly important factor for individual organizations seeking to expand their product development and service offerings [31]. AR systems used in manufacturing are developed using different software and can be categorized as either open development platforms or extensions of established commercial software [28]. However, engaging individuals in platform development is crucial to establish the thorough usefulness and scalability of internal value. Building internal momentum is a socialization process that strengthens the integration process [32]. The growth in expertise builds on anticipated role expansion, where immersion in AR becomes part of the strategy and operational tactics. In cases where this link between strategy and tactics is missing, well-intended attempts may impede learning and the production of valuable use-cases that could be further pursued [7].

Insufficient resources and knowledge of technology integration and knowledge progression often limit the potential offsets for efficient adoption to occur. This is underlined by supplier involvement and the need to mitigate technological and process challenges, which requires increased awareness to enhance the value within the supplier and user constellation [33]. Past attempts to implement AR frequently encountered obstacles or entered vicious circles, resulting in untapped business cases and unrealized implementation value [20]. This involves the integration of data and information, which can potentially be facilitated at various levels of maturity [34], and requires the alignment of people, processes, and technologies acting as pillars for digital capability [35]. The challenges faced by existing frameworks in incorporating AR [20, 28] highlight capabilities and antecedents that incentivize AR adoption as a mechanism for change and upskilling [27]. Users' prior knowledge functions as a baseline for cognitive capacity and decoding efficiency when it comes to learning. Although prior knowledge simplified processing, this repository of prior knowledge can in certain situations have a negative impact on learning [36]. To overcome integration shortcomings, recent research emphasizes the need for a more systematic approach to testing new applications. which can benefit the functional adoption process [37].

2.3 Purpose

The need to increase our understanding of the transformative effect of AR implies strong reasons for conducting research that explores the attention of pedagogy to understand scalability of AR in practice. Using the theoretical lens that outlines a

technology acceptance model, decisions to adopt emerging technologies have been shown to deviate based on technology readiness and usability thresholds [38]. Consequently, this study approaches AR from a meta-perspective by adopting a user-centric approach that builds on each unique configuration of people and technology in each case senario. This paper focuses on minimizing the uncertainties that many industries today when adopting AR and facilitate the internal scaling of this technology. Assessing the value derived from perceived actions using AR entails a comprehensive evaluation of the pros and cons that have implications across various aspects, ranging from tools, implementation, operations, learning, performance, output/performance, and strategy. This evaluation process determines value rooted in the socialization of technology aspects, which are framed as onboarding learning processes. While the term "onboarding" is far from new; yet, with new technologies overwhelming new user groups, it has become a crucial step for new users, i.e., employees and employers; it has become a crucial step that is often overlooked by both parties [39]. This theoretical outlook is encapsulated in the research question: "How can the adoption of AR bring clarity to learning purposes and corporate values?"

3 RESEARCH DESIGN

This paper adopts a qualitative approach in merging industrial needs for extended reality through the adoption of new technologies, allowing shorter and intensified ways for creating efficiency in learning and performance. To build the framework for this study, an extensive literature search on XR and AR was done using primarily Scopus, EBSCO, and Google Scholar, with a concentration on the past five years and a combination of keywords that, besides tools and technologies, included education, learning, implementation, adoption, value, and/or assessment. Siggelkow's [40] arguments on case selection portray supplier relationships that need to deviate from normal processes to access high technology from new distributors. Two prominent technology suppliers in the Scandinavian market, XMReality AB (XMR) and Librestream Technologies Inc. (LT), were selected based on their market share, openness, and overall activity level in the field of AR. Yin's [41] multiple holistic case study approach was used to examine each case individually and gain a comprehensive understanding of its unique characteristics, context, and dynamics. A total of six industry professionals from the two different suppliers were interviewed for the study.

In addition, five semi-structured interviews were conducted with teachers to capture their academic perspectives, variations, and beliefs regarding the introduction and facilitation of learning using AR. However, upon analyzing the perspectives obtained from industry professionals, it was observed that the academic perspectives contributed only minimally to the overall understanding of the subject. In order to maintain the focus on the contextual industrial relevance of the findings, the decision was made to exclude the academic dataset from the analysis. To ensure the authenticity and relevance of the data the study employed interviews and workshops to establish the real-world use-cases. A snowball approach was adopted, allowing for in-depth exploration through probing questions. The interview questions were developed using an exploratory approach, combining open-ended questions that were given on multiple occasions.

The interviews conducted for this study lasted between 40 to 60 minutes each and were followed up with email clarifications, and in two occasions with a digital follow-up interview (using Zoom and Microsoft Teams). By purposely using pedagogical guidance and testing, the initial overview of AR explored value propositions

extracted from demo workshops. In the demo workshop, years of collaboration and refinements were shared to build authentic cases with other existing users. In addition, critical use cases were shared by past users on how to manoeuvre and strategically establish a transition toward an integrated use of AR. The data provided an overview of elements and value-added features, which, as in past studies, were deemed critical to AR implementation [42]. AR case descriptions with both supplying companies were finalized using follow-ups using email and Zoom. A triangulated approach was used involving descriptions by XMR and LT to establish implementation phases. Notably, for XMR, implementation was explicitly phrased as their "onboarding program" and consisted of internal archival records, interviews with the responsible onboarding manager and technical specialist, and an onboarding use-case company description.

The study is delimited to the case description of how learning activities and cognition systematically can be improved through supervised learning experiences aimed to familiarize users to authentic scenario training.

4 EMPIRICAL EVIDENCE: THE ONBOARDING PROCESS

Being a customized learning approach, onboarding offers training for new users; it can also be a checklist to finalise completion of joining formalities. Offering the onboarding learning procedure is relatively new. Besides providing essential introductory learning, onboarding can at times result in an inefficient user experience due to information overload. According to respondents, bad judgment causing mistakes in the preparation of the learning progression can affect an organization's operational parts. This will inevitably cause delays in making a new employee productive and create a low level of engagement and retention. Both XMR and LT, the respondent companies in this study, have developed and refined their onboarding process over the years. These processes have become formulated and embedded learning routines within their respective organization. Assessment from a company perspective has been highly concentrated on individual value gains that can be portrayed in various use-cases. To minimize adoption thresholds, onboarding has been implemented to allow a stepwise facilitation process to ensure a more autonomous practice by users (i.e., learners). The onboarding process shares similarities between the two cases, with the normal process lasting between three to six months.

During these steps, XMR presented activities connecting company interests with enabling an upskilling process of new users (as follows):

0. *Handover (pre-step)*
   The initial step is taken when the sales manager hands over customer information to the customer experience team. This includes relevant information about the customer and the terms of the deal, so that the customer experience team can use this background data to prepare for the onboarding process.
1. *Get Started*
   The customer experience manager activates the AR domain and contacts the customer to schedule a kick-off meeting. On the customer's side, a designated roll-out AR specialist, tech responsible officer, or a team will typically provide training to the users.
2. *Kick-off Meeting*
   In the kick-off meeting, the aim is to understand the customer's underlying needs, as proper use and desired functionality on the customer's side are critical for usability and intended value concerns. By targeting and asking probing

questions about their needs, a more tailored program can be put in place to meet their unique requirements. Discussions focus on use cases, roll-out plan, goals, targets, how to measure success, how to conduct training, and follow-up work.

3. *Training*

   User training is decided upon during the kick-off meeting. Based on a variety of offerings depending on user needs, functions like "admin," "user," and "smart glasses" are provided through distinct training programs. The learning efforts are focused and aimed at the customer's specific target group, meaning that tools are provided in a "train the trainer" manner. The training step can take different forms, such as on-site exercises or formats that focus solely on remote practice.

4. *Roll-out*

   Involvement of users in the process focuses on communication, training, testing, and the official start of using the software by the adopting company. Based on interviews with XMR, all respondents mention that Step 3(training), and Step 4(roll-out) are intertwined, and that no official marker exists to define any precise handling differences. If a project is completed, it automatically becomes the responsibility of the receiving company to make efforts to succeed with roll-out activities internally.

5. *Follow-ups*

   XMR conducts three follow-ups with the customer during the onboarding process, i.e., about two weeks after training, after one month, and after three months. During these follow-ups, the attention given differs and depends on the customer's needs and requests. The purpose of the first follow-up is to ensure that the customer is getting started and has everything they need from XMR, as well as to set short-term goals. The next follow-up aims to evaluate the customer's initial experience using the software, adjust goals for the next period, and address the overall onboarding process. The final follow-up evaluates the onboarding process, updates goals to more long-term goals, and establishes parameters for ongoing partnership and communication after the onboarding is completed, upon reaching step five.

Figure 1 reveals that the explicit respondent formulation slightly deviates from the handling of program activities and processes. Timing and variations in requested support are aligned with the customer's needs. Various activites are available to support a smooth adoption process, including helpdesk assistance, technical support, maintenance, installation, variations of training formats, and testing.

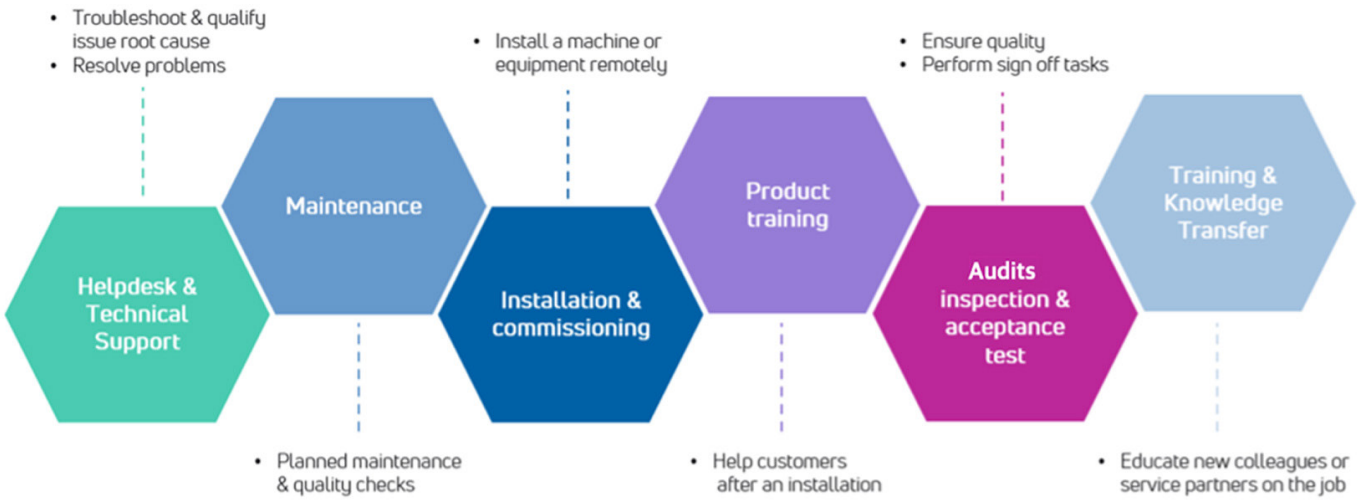

Fig. 1. XMR onboarding program

LT considers user requirements as the most critical challenge, and therefore, essential input provided through suggestions and inspiration from user experiences. When approaching AR adoption, LT places a high priority on understanding the unique challenges associated with each customer project. Customers of LT vary from one another, and present unique use cases, with differerences in complexity between B2B and B2C business that impact internal usage. LT emphasizes that, "It is important to prove the added value of our AR software on both company level and to the individual user. Otherwise, our customers will struggle with user adoption and low usage." To improve user adoption, LT conducts follow-ups to assess the status of active users, comparing their progress with targets and defined use cases. The company seeks to define milestones for the customers related to purchases, user adoption, and activities that drives their customer. Until half a year ago, the case company LT did not have a well-defined onboarding program. Customers were charged for one to two hours of training and were considered "ready to go." This transactional approach made it challenging for LT to track the customer journey. Support activities that involved handling user questions as they arose resulted in time-consuming support, impacting system-development priorities.

LT promotes their AR solution as a "simple-to-use tool." However, they also acknowledge the challenges they faced with slow user adoption processes. They soon realized that addressing more fundamental needs, such as changing established work practices, was essential to foster understanding and enhance adoption. LT believes that their concurrent meetings, which are part of their onboarding process, can effectively manage this. In order to facilitate smooth navigation and capture the attention of the user companies and their respective individual users, LT's onboarding program (see Figure 2) incorporates customized training sessions, various learning modules provided through e-learning courses, self-guided "how-to guidance," on-demand remote virtual assistance, and a training certification to validate expertise in the offered AR solution. LT presents a range of options to build in-depth knowledge to their AR offerings, considering it as a collected extended value offering. Although no defined process steps were found, the respondent explained that the onboarding program, comprising the support offerings, is customized in collaboration with each customer shortly after contract agreement. In some cases, experienced customers may want only access to the AR solution; in which case the provided onboarding learning activities are considered an integral part of their more recent service agreement.

Fig. 2. LT onboarding program

5 MAIN FINDINGS FROM THE ONBOARDING PROCESS

The success of the onboarding program relies on a set of common features that encompass various change-management areas:

- Reassurance of resources: Reassurance of resources involves management authorizing delegated decision-making for adjustments and learning operatives responsible for identifying "site champions" as proactive supporters in the adoption process.
- Planning for sufficient time: Users are prepared for self-governance, and there are different levels of entrance to accommodate various user preferences.
- Flexible task-assistance: Seamless user experience is supported by validating connected interactions, minimizing misinterpretations and misunderstandings.
- Defining capacity: User needs are distinguished, although XMR and LT acknowledge that perceived value may differ between groups such as top management and internal end-users, leading into inefficiencies in the adoption process.
- Involvement and engagement of targeted end-users: The adopting organization ensures active participation of end-users in the process, follow-up and roll-out.
- Impact through manifesting AR use: When end-users see the value that the tool brings to their work, user adoption increases, and change happens from the bottom up. LT revealed that their most successful customers attributes the effects to their return-on-investment.
- Incorporating support: Support is provided to bring about distinct changes in relation to actionable work practices.

In responses from tech experts, both short-term and long-term ambitions emphasizes the importances of upgrades and leveraging intelligence throughout the organization. AR provides significant benefits in terms of accelerating decisions, reducing costs, increasing productivity, and improving worker safety. From the user's perspective, adopting AR involves various aspects, but is not limited to, technical layout and information flows. With a rapid increase and demand for systems that are self-sustained, visual and remote access to existing knowledge become more crucial than ever. Preparing a smooth transition interface, which involves clear routines and emphasizes transparency via communication, can potentially increase the impact of AR use cases. The stepwise learning procedure aims to ensure user value throughout the implementation phase and has been deemed successful by both XMR and LT, leading them to recently formalize a path to support new users.

6 ANALYSIS

This paper sets out to answer the question: "How can adoption of AR bring clarity to learning purposes and corporate values?" To address this question, the answer is divided into two aspects. The first aspect focuses on the "adoption process of AR," which involves navigation through varius steps that culminate in increased learning. The second aspect explores how to establish "clarity to learning purposes and corporate values," emphasizing the content relevance, individual user commitment, formalized process, and purpose and agenda for implementation. Explicit in both cases, the onboarding program is considered a tool aimed at users to shorten integration time and, as such, increase learning and AR adoption time. However, several hurdles must be overcome for a user organization to fully make an escalated

transition where a multitude of platform compatibilities and stand-alone robustness face increasingly specific customer-derived demands to consider. The starting point for determining how to proceed with an adoption process involves goal-setting and acknowledging value directives, as supported by growing body of research in this field [6, 9, 17, 34, 43]. In this study, this is paraphrased as "synergy effects" between an AR-generated immersive presence and a user-oriented functional practice. These synergy effects have varying impacts on learning processes, depending on the maturity level. The onboarding process sheds light on what has been declared as initial adoption stimuli [29], to overcome user thresholds. This is particularly the case when more complex processes are investigated involving a higher degree of deepened learning. What has been characterized as socializing activities has also become a way for previous studies to consider the success of technology enactment [32].

The onboarding cases present the importance of familiarization as a key to successful purpose-driven escalation. This involves understanding the specific needs of users and providing incentives [27] to facilitate a smooth roll-out and promote autonomous learning from the learners' perspective. The characteristics of the onboarding vary in terms of formats, however, recent work in the field [7, 15] can provide insight into how to scale-up learning adoption. AR constitutes a significant add-on benefit to existing industrial products and is a part of a complete service offering aimed at educating audiences, with in-built potential for customization. The delivery of perceived value becomes an ongoing process of customizing offerings in the follow-up phase and through designated application updates. This also shortens learning curves and minimizes thresholds and potential bottlenecks and up-time when using AR. The visual execution facilitated by AR esures a secure process, enabling both individual and organizational engagement and serving as a catalyst for knowledge expositions. Similar to previous studies involving end-users [44], AR applications should strive to ease decision-making, target audience characteristics, reassure content management strategies, triggers, and users' exploitation. From an individual's perspective, AR acts as a boundary spanner, allowing users to experience enriched contextual depth and expand beyond traditional domains and roles. Learning engagement plays a distinct moderating role in acquiring AR skills.

Building on user experiences, the capability to extend AR practices throughout across an organization can be challenging due to short-sighted financial expectations. However, transitioning to a more open approach to AR integration can alleviate unnecessary holdups and delays and fulfill exploration and exploitation ambitions. Just as AR is used in information delivery to enhance higher-order thinking capabilities [23], the user adoption process enables independent problem-solving, dealing with complexity, and fostering critical analysis. Different industries and universities have distinct reasons for adopting AR, and maintaining authenticity is vital to ensuring individual relevance. At an organizational level, flexibility in task benefits and time management becomes even more impactful in addressing the need for clarifying value propositions for the AR adoption process [20, 38]. In concern for corporate-aided AR training [22], this study identifies four key distinctions that can facilitate the learning curve:

1. Value offering: Efforts should match perceived value by determining the level of presence and engagement in adoption efforts. A strong commitment from organizational levels can help formalize and realize the potential of use-cases.
2. Time-to-value: The maturity level and adoption among users play a crucial role in further escalation. Responsiveness and internal traction are essential for effective roll-out plans and maintaining momentum.

3. Learning approach: Individual learning can be enhanced through immersive practice and collaborative engagement. Creating opportunities for skill sharing and fostering a positive and open mindset can lead to growth and critical dialogue.
4. Empathy and flexibility: The onboarding process and autonomous learning progression can provide a systematic approach to absorption. Shifting mentality away from quick-fix solutions and focusing on organizational objectives can promote iterative testing and increased tolerance for failure.

Usability and learning approach are becoming increasingly important in engaging learners due to growing complexities. Research has shown that the adoption process is influenced by factors such as organizational fit, individual task-related benefits, and motivating value considerations, adding to its complexity. The integration threshold takes into account the perspectives of both the provider and adopter; allowing for variations based on technology readiness and usability. To calibrate needs, the level of empathy and flexibility exhibited by the provider can be aligned with the adoption process. The onboarding approach places emphasis on customization to generate maximum perceived value. However, it still remains uncertain how much and what kind of interaction within the adopting organization leads to value creation. The analysis indicates that the growth of AR skills leads to increased problem-solving capability and autonomy, thus accelerating the establishment of cognitive and functional understanding. The provider's value offering and learning approach are determined by the level of empathy shown, while the perceived value for adoption is based on operational capacity and inherent flexibility of the solution. Overcoming the integration threshold is key to a smooth adoption process with minimal disruption to traditional practices. Figure 3 illustrates the connection between the perspectives of the provider and adopter as sources of scientific and experienced knowledge.

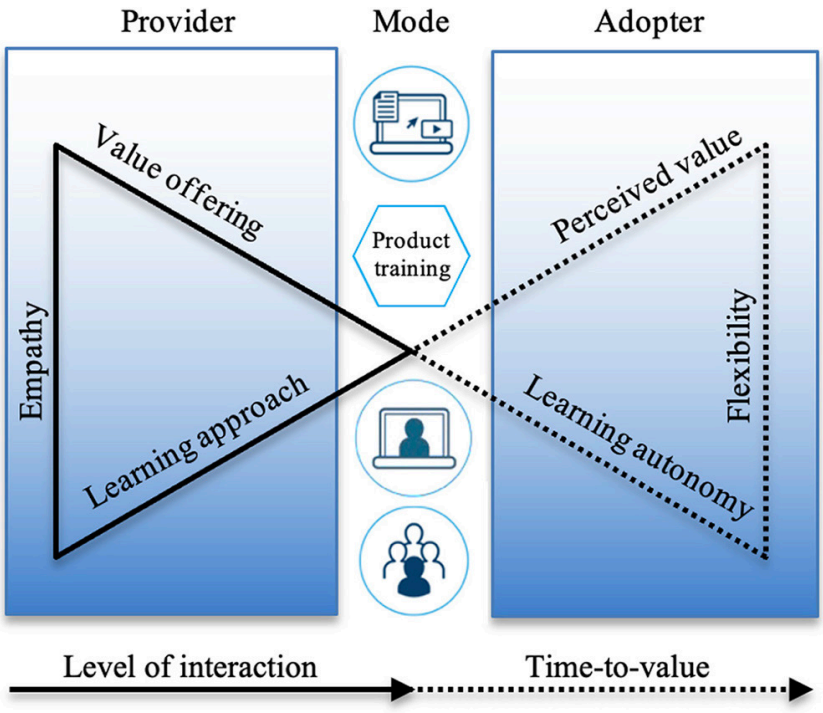

Fig. 3. Threshold integration framework

From an educational perspective, lessons learned from experiences gathered in use-cases are essential for building wisdom and developing actively engaging knowledge repositories. The mode of onboarding activity interlinks the chosen form and level of interaction with cognitive growth based on customized AR offerings. Overcoming the integration threshold is a multifaceted approach, involving strategy and operational tactics. The onboarding processes provided by companies such as XMR and LT facilitate the utilization of AR by offering a well-integrated and organizational support structure. This includes relevant, user-derived materials such as interactive media, graphics, texts, and videos, which help to prevent incidental cognitive loads. To ensure time-efficient value, the onboarding process for AR should be flexible and prioritize user satisfaction, motivation, and interaction.

7 CONCLUSIONS

This paper focuses on overcoming the adoption thresholds of AR by addressing authentic educational challenges and industry relevance. The study highlights the importance of achieving a balanced progression of user-centric AR activities by aligning them with anticipated cognition levels of the users. The findings indicates that providing distinct task-based facilitation and customized proactive learning sessions, can significantly increase the attention rate and engagement of AR users. To systematically overcome the integration threshold, a structured process is implemented, which facilitates existing users and new adopters, through customized guidance. As with a more generic belief of onboarding, a carefully constructed onboarding process carries high efficiency in establishing impact on productivity. Preparation is then set to establish a high level of motivation and assure engagement to establish a self-directed learning approach. By focusing on specific scenarios and use-cases, it becomes possible to operationalize a systematic engagement level that influences factors such as tolerance for failure, design elements, and overall efficiency. However, there is a need for further research to understand the transfer of knowledge between learners and to identify comprehensive evaluation practices for integration of technologies like AR effectively. Emphasis should be placed on generating a systematic customization process that builds upon existing user-driven values. The practical significance of this research lies in the realization that well-prepared and systematic activities that stimulate cognition provide a crucial link to increased learning autonomy. The threshold integration framework offers a progressive approach, strengthening the practical and theoretical role of a structured onboarding process. By addressing weaknesses and process gaps in the onboarding process, the framework can be further validated through additional illustrative examples, shedding light on the interaction dynamics between providers and adopters.

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