Research

A.4 Identifying key features and user experience criteria for an online community platform in the nuclear power sector. A user-centered approach

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1 Introduction

The current decommissioning of nuclear power plants in Germany, following the completion of the nuclear phase-out in 2023, is a complex and long-term process that requires highly qualified specialist personnel. However, a substantial number of professionals in this sector will retire in coming years, while educational programs to qualify new staff have declined significantly since the phase-out began (Kettler et al., 2025). Consequently, a gap is emerging between the demand for professional expertise and the availability of qualified personnel needed to continue decommissioning in a compliant and safe manner. Given the decrease in (non-)formal training and continuing education programs, (alternative) approaches are needed to attract, train, and retain emerging professionals (BMWK & BMUV, 2020). Suggested measures include intensifying national and international networking, advancing teaching methods, and strengthening knowledge management and preservation (BMWK & BMUV, 2020). Consequently, we consider developing and establishing a domain-specific community platform as a promising approach in this regard. Such a platform could enable future personnel to acquire competencies through aggregated content, web-based learning formats, and interaction with peers and experts. It may also assist in identifying ongoing face-to-face learning opportunities. However, in our search for inspiration and guidance, we found that there are currently very few comprehensive platforms that meet the necessary conditions for such purposes. Moreover, scientifically grounded design principles – both general and domain-specific, such as in the nuclear sector – are often outdated (e.g., Gurzick & Lutters, 2009) or limited to purely educational platforms (e.g., IAEA, 2009; Mayer & Fiorella, 2021), highlighting a research gap in the systematic development of community platforms (for technically specialized fields). In the present article, we address this gap by outlining the theoretical rationale, methods, and findings of two empirical studies conducted to explore how an

online community platform (for the nuclear power sector) can be designed to maximize user acceptance and actual use.

1.1 Online social learning community platforms

Online communities are aggregations of "individuals or business partners who interact around a shared interest, where the interaction is at least partially supported and/or mediated by technology and guided by some protocols or norms" (Porter, 2004, p. 1). Depending on the members' motives, these highly dynamic and evolving communities (De Souza & Preece, 2004) can serve various purposes. A prominent example are *communities of practice* (e.g., Pyrko et al., 2019), where people sharing a professional interest or passion come together to deepen their expertise through regular interaction (Wenger, 1998; Wenger et al., 2002). Most online communities rely on web platforms to support interaction. They often incorporate features similar to social media platforms, such as algorithm-based personalized feeds (Eg et al., 2023; Leimeister et al., 2002), system notifications (Shulman et al., 2023), comment functions, public content sharing, and profile pages (Tapiador & Cerrera, 2012). Additionally, they commonly include features for information – like directories (of members, contacts, and experts), news or literature repositories, event calendars, and friend lists – and interaction – for example forums, chats, and group calendars (Leimeister et al., 2002; Leimeister & Krcmar, 2005). Examples of online community platforms include *ResearchGate.net* (for science), *SteamCommunity.com* (for gaming) and *Reddit.com* (for multi-topic discussions).

Possibly inspired by Massive Open Online Courses (MOOCs; for an overview see Papadakis, 2023), community platforms are increasingly integrating features designed for educational use. These include learning materials and modules (e.g., PDFs, videos, or web-based trainings), collaborative tools (e.g., shared documents and wikis), and (self-)assessment features (Franke & Handke, 2012; Niegemann & Weinberger, 2020). In this way, *online social learning community platforms* emerge. Recently, artificial intelligence mechanisms such as automated content summarization and discussion moderation have also gained relevance for online community platforms (Axelsen et al., 2023; Cao et al., 2024). One of the few comprehensive platforms combining social, informative, and educational elements is *LinkedIn.com*. In 2015, the professional network integrated *LinkedIn Learning* – formerly the standalone platform *Lynda.com* – to offer structured educational content. Reflecting the limited number of such platforms, there is still a notable lack of empirical research and corresponding design principles for online social learning community platforms, especially for domains-specific contexts such as the nuclear power sector.

1.2 Technology acceptance as a foundation for online community platform design

To establish a contemporary preliminary framework for systematically exploring and deriving of design principles for online social learning community platforms, it appears fruitful to draw on fundamental models of human-computer interaction, such as the Technology Acceptance Model (TAM; Davis, 1989; Venkatesh & Bala, 2008). At its core, TAM posits that the *perceived usefulness* of a technology is influenced, among other factors, by its *perceived ease of use*. Both constructs jointly predict users' *behavioral intentions to use* the technology, which in turn leads to *actual use* (Davis, 1989; see Figure 1).

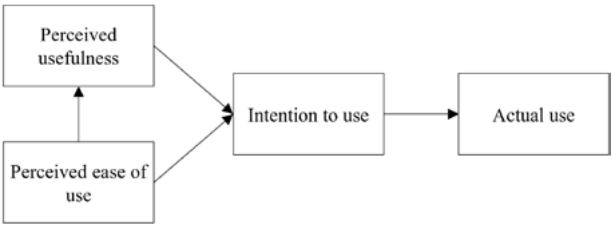

Figure 1: The technology acceptance model (Davis, 1989)

In the context of online social learning community platforms, this implies that simply implementing state-of-the-art technology does not guarantee user engagement or platform success (Rychwalska et al., 2021; Young, 2013). Instead, besides social dynamics (i.e., sociability), success depends on the platform's functional quality and usability of the platform software (De Souza & Preece, 2004) – core components of the overall *user experience*. The latter can be defined as "a person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service" (ISO, 2010, p. 3). It encompasses both hedonic and pragmatic dimensions (Hassenzahl, 2010). The hedonic aspect addresses emotional and experiential qualities, such as beauty, stimulation, and immersion, which contribute to user satisfaction and engagement (Winter et al., 2017). The pragmatic dimension relates to the system's (perceived) usefulness and usability in achieving task-related goals, including clarity, controllability, intuitive operation, usefulness, efficiency and transparency (Winter et al., 2017). Building on this theoretical foundation, we propose the following research question:

> ***How should an online social learning community platform be designed to enable high levels of usage through an optimal user experience?***

2 Method

To address the research question comprehensively, we conducted an in-depth investigation of the three key determinants of user experience and technology use as conceptualized in the TAM. It was divided into two separate studies, as each study pursued distinct objectives, focused on different units of analysis, and required a specific methodological approach. While the first explored perceived ease of use though qualitative user testing of platform design aspects, the second assessed the perceived usefulness of platform features via a standardized survey.

2.1 Study on perceived ease of use

2.1.1 Research design and subject

The first study aimed to identify which functions and interaction mechanisms should be adopted or adapted for the design of online social learning community platforms – both generally and specifically for the nuclear power sector. Given that user-friendliness is a tangible phenomenon and the reasons behind user perceptions of specific design features were of primary interest in this regard, a qualitative research approach was chosen. Specifically, qualitative shadowing was applied as a method (MacDonald, 2005), involving real time observations of users followed by immediate interviews to deepen understanding and clarity of their behavior (McDonald, 2005).

Research instruments were developed prior to data collection. These included (1) eleven standardized tasks representing typical uses (e.g., adding a course of study, joining a technical group, sending a message, or searching for training videos), (2) a structured observation checklist and (3) a guide for subsequent semi-structured interviews. The checklist captured both user interactions with the platform and verbal/non-verbal cues during task executions, referencing selected user experience aspects – beauty, stimulation (hedonic), clarity, controllability, and intuitive operation (pragmatic). The interview guide contained follow-up questions tied to specific observations („In task ... you ... – why?“) as well as general prompts when few cues were observed (e.g., ”How clear did you find the platform?“ to assess clarity). All instruments were pre-tested with three experts and refined based on their feedback. Since no dedicated online community platform for the nuclear power sector currently exists, the – previously mentioned – combined platform of LinkedIn and LinkedIn Learning was used as a reference model.

The study followed a consistent protocol to ensure high administration objectivity. Test persons were welcomed by trained observers, received brief instructions and were familiarized with the notebook computer used. They were instructed to verbalize their thoughts throughout task completion. Next,

user tasks were presented in randomized order orally and in written form. Task completion lasted between 30 and 45 minutes. Subsequently, observers reviewed their notes, formulated follow-up questions and conducted a post-task interview lasting 20 to 30 minutes.

2.1.2 Sample

To incorporate diverse perspectives on the design of online community platforms, the study included both novice and expert participants in the field of user experience design. The novice perspective was (due to reasons of research economy) represented by three female prospective teachers aged 20, 23 and 24. The expert perspective was covered by two female user experience designers aged 38 and 40, with 15 and 5 years of relevant professional experience, respectively. The findings from both groups were weighted equally and analyzed additively.

2.1.3 Data analysis

The digitally recorded data were transcribed using TUCAN.ai and analyzed through qualitative content analysis, following a hybrid coding scheme (Mayring, 2022). Deductive categories were derived from the five user experience criteria in the observation checklist and extended by an inductive category capturing participants' design improvement suggestions. Coding was based on a codebook containing scientific definitions, anchor examples for each category, and rules for distinguishing similar categories. To ensure intercoder reliability (Mayring, 2022), all data were independently coded by at least two trained researchers, with discrepancies subsequently discussed and resolved.

2.2 Study on perceived usefulness and use intention

2.2.1 Research design

As outlined earlier, the TAM (Davis, 1989) posits that perceived usefulness of technologies is influenced by their perceived ease of use. To assess the perceived usefulness and intended use of specific components and functions for an online social learning community platform (in the nuclear power sector), an unspecified attitude elicitation was conducted. The study focused on 17 potential features, identified based on scholarly literature, and aimed to capture how members of the immediate target group evaluate their usefulness and likelihood of use.

2.2.2 Measures

Data were collected using a mixed-format online questionnaire, which enabled efficient and consistent gathering of comparable responses across participants, independent of time and location (Döring, 2023). The instrument comprised 19

bound and 19 open-ended questions covering sociodemographic and aspects of technology acceptance.
Sociodemographic data included participants' age, perceived gender, current professional occupation, job position, and work experience, assessed through five questions with suitable items.
Perceived usefulness and *intention to use* were each measured for 17 potential platform features – such as personalized feed, AI assistant, thematic forums, or learning modules – based on a reduced version of Davis's (1989) original TAM scales. To minimize respondent burden (Döring, 2023), they were condensed to one item each. Ratings were provided on two 6-point Likert scales ranging from "Not at all useful" to "Totally useful" (for perceived usefulness), and from "I will use it very rarely" to "I will use it very often" (for use intention). To ensure consistent understanding of each feature, brief explanations were presented alongside each question. To explore the rationale behind these ratings, participants were also given the option to elaborate each response in an open text field.

2.2.3 Procedure

The survey (available in German and English) was distributed via email to contacts in the nuclear power sector – including company staff, members of professional associations, and academic faculty – and additionally promoted through personal outreach and flyers at specialist events. Participation was anonymous and self-paced, with respondents completing the questionnaire independently, regardless of time and location. In total, 38 complete responses were recorded (five in English), corresponding to a low response rate relative to the estimated reach. The responses collected were subsequently analyzed using descriptive statistics (bound questions) and qualitative content analysis with basic thematic coding (open-ended questions).

2.2.4 Sample

The final sample consisted of 38 participants (24% female, 76% male), most of whom were either aged between 25 and 34 (18%), 35 and 44 (45%) or between 45 and 54 (24%). Only two respondents were younger than 25 (5 %) and three were older than 54 (8 %). In terms of occupational background, most participants worked in safety research and analysis (21%), radiation protection and monitoring (18%), nuclear technology and engineering (18%), decommissioning and waste management (13%), or safeguards and security (11%) – representing key domains of professional activity within the nuclear sector. Regarding their roles, respondents primarily held management or leadership positions (32%), followed by scientific or research-related functions (26%), engineering (8%), and advisory roles (8%). On average, participants reported 11.8 years of professional experience (*SD* = 8.79; range: 0.5–35.0 years).

3 Results

3.1 Study on perceived ease of use

In the qualitative shadowing study, *clarity* – a subcategory of *pragmatic* user experience *quality* – was the most frequently coded aspect (45 codings), with a predominantly negative valence (36). Participants criticized the overcrowded landing page and reported initial difficulties navigating between the platform's social and the educational components. Additional confusion stemmed from ambiguously labeled buttons and input fields. Moreover, the large number of pop-up notifications led users either to overlook relevant messages or to feel annoyed. *Intuitive operation* was the second most frequently observed or mentioned (42), again with a predominantly negative tone (32). For example, several test persons unintentionally saved entire courses instead of individual videos (as required in the associated task), attributing this to the overly similar presentation of both elements. A green checkmark was repeatedly misinterpreted as indicating successful saving, despite its different intended meaning. The share button was discovered only after lengthy searches or with assistance, as it was placed inconsistently with established video platforms. However, observers positively noted that participants used many functions intuitively via icon labels, and performed repeated actions with growing confidence. *Controllability* (28 codings), was exclusively evaluated negatively. Users startled by the autoplay of videos and confused by several search bars yielding different and or unexpected results. Additionally, they expressed irritation that essential functions such as messaging users outside one's network required payment.

In contrast to these pragmatic aspects, the *hedonic quality* dimensions were only rarely observed or stated. *Beauty* was coded six times (two negative), with some participants appreciating the platform's visually appealing design and use of icons. *Stimulation* received five codings (four negative), as users criticized that visual highlights appeared random and did not support content-related orientation.

3.2 Study on perceived usefulness and use intention

To reflect the functional aims of online social learning community platforms, namely to support learning, interaction, and knowledge exchange, the 17 assessed platform features were grouped into five categories for analysis based on their didactical function and interactional affordances (Meister, 2005): Information seeking and management (see yellow-colored bars in Figure 2), communication (orange), collaboration (blue), and receptive and exploratory learning (green). The features rated highest in terms of perceived usefulness were the directory of education and training programs (M = 5.24, SD = 0.91), learning materials (M = 5.03, SD = 1.20), and technical articles and scientific publications (M = 5.05, SD = 1.37).

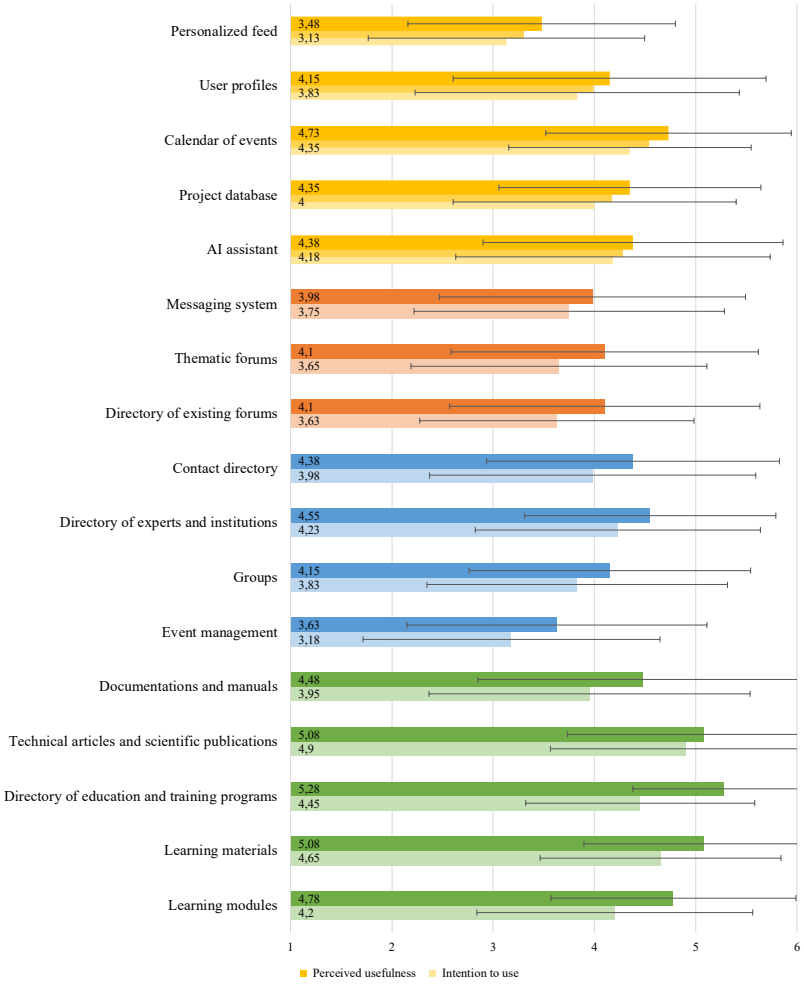

Figure 2: Perceived usefulness and use intention of potential community platform features assessed by the target group

The same features also received the highest average scores for intention to use, though in a different order: technical articles and scientific publications (*M* = 4.84, *SD* = 1.35), learning materials (*M* = 4.58, *SD* = 1.18), and directory of education and training programs (*M* = 4.37, *SD* = 1.10). In their explanations given in the open text fields, respondents particularly valued having centralized

access to all relevant learning opportunities and publications in one place to keep overview, stay informed and share them with colleagues and students.
The features rated lowest in perceived usefulness were personalized feed (*M* = 3.47, *SD* = 1.35), event management (*M* = 3.58, *SD* = 1.46), and messaging system (*M* = 4.00, *SD* = 1.54). Event management (*M* = 3.11, *SD* = 1.43) and personalized feed (*M* = 3.11, *SD* = 1.39) also ranked among the lowest in use intention, alongside the directory of existing forums (*M* = 3.55, *SD* = 1.33). In their qualitative feedback, participants noted that these features are time-consuming to maintain and that well- established external tools already exist for for these functions, which they preferred to link to rather than replicate. The full descriptive results are presented in Figure 2.

4 Discussion and conclusion

Together, the two conducted studies demonstrate that users (for the nuclear power sector) primarily desire a clear, intuitive, and easily controllable online social learning community platform that emphasizes informative and conventionally educational features. In contrast, social features – especially when equivalent tools already exist – and aesthetic aspects were of secondary importance. Based on these findings, we formulate several design recommendations, some of which align with established principles of multimedia learning design:

- *Less is more* (e.g., Mayer, 2014): The platform should offer a streamlined and clearly structured user interface, particularly in integrating social and educational components.
- *Clarity and familiarity:* Design should follow widely adopted web conventions, with clearly labeled and unambiguous interface elements.
- *Accessible and intuitive use:* Essential features must be freely accessible and operable without prior instruction to minimize user frustration.
- *Effective search functionality:* A centralized, efficient search tool should support easy access to relevant content.
- *Guided self-controllability:* System-driven actions (e.g., auto play or pop-ups) should be avoided in favor of subtle user guidance, such as highlighted elements (signaling principle; Fiorella & Mayer, 2021).
- *Clear value proposition:* New platforms should explicitly define their added value compared to existing services and align their design accordingly.
- *Smart integration:* Rather than replicating existing tools, platforms should link them meaningfully to complement their own offerings.

Taken together, the findings offer concrete and applicable guidance for the development of a nuclear power online social learning community platform. Furthermore, the identified principles are not exclusive to the nuclear power

domain but may also inform the design and optimization of community platforms in other technically specialized fields.

Some limitations must be acknowledged. Despite considerable outreach, the sample size of the quantitative survey sample remained modest, with most participants identifying as male and aged 30 or older. While this demographic profile is broadly consistent with the current workforce structure in the nuclear sector, they may underrepresent the perspectives of the young professionals as a key target group of the platform. Given their potentially higher affinity for social media and features (e.g., Zhang & Jung, 2022), their needs and preferences may differ significantly from their older colleagues. As such, further data collection efforts are underway to better reach this group. We also encourage future research to validate, refine, and extend the proposed design principles across a broader range of fields and user groups to support the development of next-generation online social learning community platforms. They may also provide valuable guidance for large-scale national education platforms, such as Germany's emerging digital infrastructure for education (Dyrna et al., 2023).

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