Deriving Design Knowledge for eLearning Companions to Support International Students

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DERIVING DESIGN KNOWLEDGE FOR eLEARNING COMPANIONS TO SUPPORT INTERNATIONAL STUDENTS

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Abstract International students often have difficulties in getting connected with other students (from their host country), or in fully understanding the lectures due to barriers such as interacting in a foreign language or adjusting to a new campus. eLearning Companions (eLCs) act as virtual friends, accompany students with dialog-based support for learning and provide individual guidance. We contribute to the lack of prescriptive design knowledge for that specific use case by deriving 16 design principles for eLCs and transferring them into an expository instantiation along the Design Science Research paradigm. We build upon 14 identified literature requirements and 15 condensed user requirements resulting from an empirical study with 76 Chinese-speaking exchange students at a German university. Our objective is to extend the knowledge base and support scientists and practitioners in eLC design for non-native students to initiate further research and discussion.

1   Introduction

Strong internationalization efforts are finding their way into numerous curricula to prepare students for future jobs in an increasingly complex and globalized world (de Wit & Altbach, 2021; Finster & Robra-Bissantz, 2020). Over the past 50 years, international student mobility has doubled every other decade, whereby China has become the lead sending country in recent years and the US is the leading host country followed by France and Germany (de Wit & Altbach, 2021). Studying abroad offers many opportunities, such as actively experiencing a foreign culture, personal development, or knowledge enrichment (Kim & Lawrence, 2021). At the same time, however, the language barrier, lacking social relationships in the foreign country and the new learning environment also create challenges for international students. These were further exacerbated by the pandemic situation (Ezepue & Metu, 2021), as almost all teaching and learning activities had to shift to the digital space within a very short period of time, resulting in less social interaction (Grogorick & Robra-Bissantz, 2021). On the other hand, there has been rapid progress toward technically enhanced interaction through conversational agents (CAs), in form of natural-language virtual agents that support the user either voice-based (e.g., Siri) or in text-based communication as chatbots (Gnewuch et al., 2017; McTear et al., 2016). Besides their widespread use in health care, customer support, and eCommerce, CAs are also conquering the educational sector due to their easy scalability, constant availability over time, and the potential to respond individually to the learner's needs (Hobert & Meyer von Wolff, 2019). These so-called "pedagogical CAs" (PCAs) range from simple, rule-based chatbots with pure assistance functions (Hobert & Meyer von Wolff, 2019) to collaborative learning partners that act proactively and aim to establish a long-term and trusting relationship with the learner, serving as eLearning Companions (eLCs) (Grivokostopoulou et al., 2020; Kim et al., 2006).

The purpose of this paper is to first identify problems and challenges in learning during an academic stay abroad in a collaborative process with foreign exchange students from China (the world's leading country of sending out students in academia) at a German university (location of the study conducted) and to then translate these into requirements, design principles, design features and an expository instantiation of an eLC building thereupon. Thus, we address the central research question (**RQ**):

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How should an eLC be designed to best support international students in learning during their stay abroad at a (German) university?

To the best of our knowledge, this particular use case of eLCs has not yet been addressed in academic literature (cf. 2.2). However, user expectations of CAs are significantly affected by the context of use (Følstad et al., 2019; van der Zandt et al., 2021). Therefore, we aim to contribute to research by introducing the potentials for the use of eLCs with nascent design knowledge derived together with international students as the future target group. We thus stimulate further research and discussion on considering eLCs to facilitate learning for non-native speakers - a potential that has high practical relevance thanks to growing internationalization efforts worldwide and urgently needed educational perspectives for an increasing number of foreign students who need effective integration into a new environment (de Wit & Altbach, 2021).

2   Methodology

In the second chapter, we introduce DSR as our methodical frame (cf. 2.1) and explain the embedded methodological approach of analyzing current literature (cf. 2.2) and the empirical online survey with the target group (cf. 2.3).

2.1   DSR as the Leading Paradigm

For IT artifacts to solve actual problems, they must be designed need-oriented, so the perspective and early involvement of potential future users is essential (van der Zandt et al., 2021). However, co-creation processes are only gradually finding their way into learning scenarios (e.g., Weinert et al., 2022). Following the approach of Khosrawi-Rad et al. (2022), we apply the DSR paradigm in a co-creation process with the target group of Chinese exchange students, to generate needs, requirements, and an implementation concept for eLCs together with and for future users. In a group of six Chinese-speaking exchange students and two researchers from a German university, we derive scientifically grounded, prescriptive design principles (Gregor et al., 2020) and an expository eLC instantiation along the DSR paradigm. Despite close monitoring of the scientific stringency in the methodological approach (*rigor*), the learners get the greatest possible freedom in setting the content focus to outline the problem to be addressed in a practice-relevant way from the perspective

of future users (*relevance*). Initially, literature requirements (LRs) are collected and complemented by user needs from an online questionnaire in Chinese language addressed to exchange students (cf. 2.3) to be then transferred into design principles (DPs) categorized along five recurring dimensions of the virtual companion canvas (Strohmann et al., 2019). These are finally instantiated in a prototypical concept for the eLC being ideated in the software *Figma*[1]. Figure 1 represents our iterative approach through the different DSR cycles (Hevner, 2007).
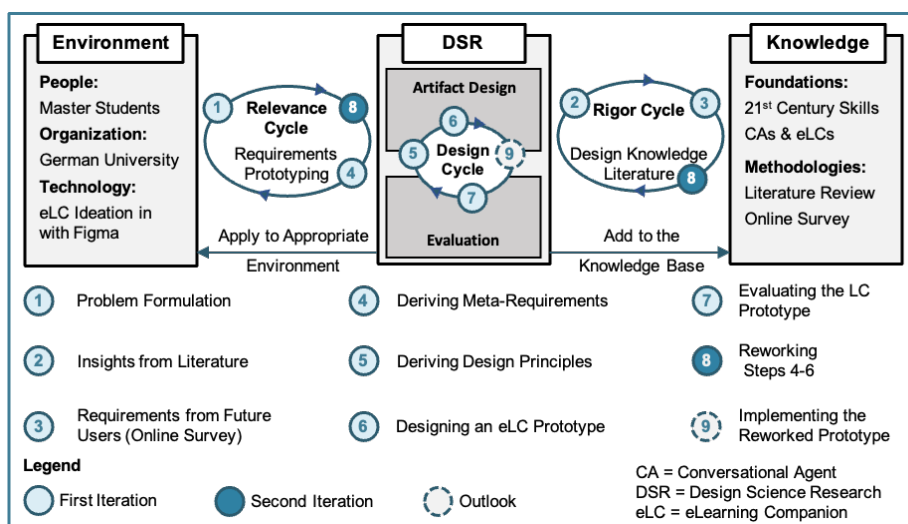

Figure 1: DSR as Leading Paradigm following Hevner (2007)

We involved international students as future users actively in the entire design process to meet their specific needs and expectations (van der Zandt et al., 2021): They shared their experiences and problem areas during their stay abroad and discussed them with other students in a seminar, actively participated in the design of the questionnaire, reflected on the derived DPs from their perspective and helped to design the prototype as co-creators (Khosrawi-Rad, Schlimbach, et al., 2022). The expository artifact was then evaluated by other, previously not involved, (international) students to check whether identified problems are tackled by the proposed solution.

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[1] www.figma.com

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2.2   Literature Review

We conducted a brief literature review according to vom Brocke et al. (2015) to derive literature requirements (LRs) concerning our RQ for the eLC design. In this process, the scientific databases *ACM Digital Library*, *Science Direct*, *Scopus*, *Springer Link*, *IEEE Xplore*, and *Google Scholar* were selected for their high relevance to the Information Systems discipline and queried the search term TITLE-ABS-KEY *("Learning" OR "Education" OR "E-learning" OR "Online Course") AND ("Conversational Agent" OR "Collaborative Agent" OR "Chatbot" OR "Virtual Assistant" OR "Learning Companion" OR "Relational Agent") AND ("non-native speaker" OR "Exchange student" OR "study abroad").*

Subsequent screening of the abstracts revealed that none of the papers addressed the design of eLCs for the specific target group of (non-native speaking) exchange students, so that we had to broaden our literature search by dropping the limitation to exchange students. As a result, we drew back on current literature reviews on PCAs (Gubareva & Lopes, 2020; Hobert & Meyer von Wolff, 2019; Khosrawi-Rad, Rinn, et al., 2022) and further supportive literature to synthesize relevant design knowledge leading to LRs that we embedded into our DSR study (cf. Section 3.1).

2.3   Conducting an Online Survey

The core for the empirical survey for identifying the needs of the future target group and their requirements for supportive eLCs was an online survey conducted from Dec 10th, 2021 to Jan 10th, 2022 via the software *LimeSurvey*. The target group was Chinese-speaking exchange students since they form the largest group of foreign visiting students at a German technical university as well as in international higher education student mobility (de Wit & Altbach, 2021) and might therefore contribute valuable insights. The survey was set up in Chinese language to facilitate natural communication and contained multiple-choice questions and free text fields. We structured our survey into five categories: *demographic data* (e.g., age), *context & learning environment* (e.g., location and noise), *problem areas in learning (*e.g., time management), *needs for learning support (*e.g., support in foreign language learning), and *expectations towards eLCs* (such as features and user interface). We reached out to the Chinese community of the university via personal approach, social networks, and email lists, generating 88 collected questionnaires, thereof 76 fully completed ones from the

target group. While we statistically analyzed the demographic data in *Excel*, the analysis of the free-text responses in Chinese was conducted by six native Chinese speakers in a manual peer-reviewed process within the team. In several cycles, they first extracted mentioned problem areas and expectations for eLCs, condensed the responses into key areas of joint mapping in the research team along the dimensions of the virtual companion canvas (Strohmann et al., 2019), and finally derived 15 user requirements (URs) (cf. 3.2.1).

3   Results

This chapter first derives LRs from scientific literature and URs from the online survey with the target group before transferring them into DPs to be instantiated exemplarily with concrete features in a conceptual prototype.

3.1   Deriving Literature Requirements

International students often face special challenges, so that their drop-out rates are higher compared to native German students - 45% vs. 28% (bachelor level) and 29% vs. 19% (master level) (Heublein et al., 2017). Many of them feel challenged with adapting to a new cultural context (Bethel et al., 2020; Jindal-Snape & Ingram, 2013; Li, 2017, 2019). Language barriers are a major difficulty of international students (Akanwa, 2015; Li, 2019; Wisniewski, 2018). Thus, they struggle in comprehending academic vocabulary (Li, 2019) and participating in class (Li, 2017). Chinese students' prior knowledge varies due to great curricular differences compared to the German education system (Li, 2019). This leads to difficulties in understanding and, in the worst case, to students failing exams (Li, 2019). Further challenges result from cultural differences; for example, asking critical questions and discussing with peers is rather uncommon in Chinese culture (Li, 2019). However, the problem source is often not a lack of motivation (Li, 2017, 2019), but insufficient support (Akanwa, 2015; Li, 2019).

During the literature review, it became clear that there is a variety of contributions about PCAs for digital learning in general, summarized in literature reviews (e.g., Gubareva & Lopes, 2020; Hobert & Meyer von Wolff, 2019) and foreign language learning in particular (e.g., Dokukina & Gumanova, 2020; Huang et al., 2021), but without being linked to the specific use case of supporting international students

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(with language barriers). Only one paper (Obremski et al., 2021) examines verbal behavior towards PCAs which are perceived as non-native speaking in mixed-cultural settings, but without deriving design knowledge to support international students in learning. Thus, we also drew design recommendations from papers on the development of PCAs in online teaching in general, although these do not address the special case of studying abroad. Categorized according to five recurring dimensions that we mapped to the virtual companion canvas (Strohmann et al., 2019), the resulting Table 1 contains derived LRs for the eLC to be designed.

Table 1: Literature Requirements for eLCs

Dimension	Literature Requirement (LR) *The eLC should...*	Literature Source
Humanoid Design	**LR1** have a humanoid design to be perceived as a social actor that embodies a role (e.g., tutoring).	Latham (2010) Pérez Marín (2021)
	LR2 evaluate language proficiency and support non-native speakers.	Obremski et al. (2021)
	LR3 react to student's mood with emotions to build rapport.	Krassmann et al. (2018)
Communication	**LR4** interact naturally to establish a social relationship.	Hobert & Meyer von Wolff (2019)
	LR5 communicate interactively and learn permanently from users.	Pereira (2016)
Interaction	**LR6** offer relevant and high-quality user interaction to stay relevant.	Song et al. (2017)
	LR7 foster a vivid interaction via animated face-to-face interaction.	Johnson et al. (2000)
	LR8 communicate proactively to encourage learner engagement.	Wu et al. (2019)
Ethics	**LR9** build a trustworthy relationship.	Rheu et al. (2021)
	LR10 consider social & ethical values for a value-sensitive design.	Ruane (2019)
	LR11 foster autonomy, fairness, and well-being of its users.	Van de Poel (2016)
Human-Computer-Relation	**LR12** make use of AI-enhanced features for smart adaptation.	Thakore (2021)
	LR13 create room to exchange expectations and concerns to constantly improve the artifact.	Thakore (2021)
	LR14 improve learner's performance by low-intensity white noise.	Othman et al. (2019)

3.2 User Requirements from the Online Survey

Demographics: Among the 76 exchange students surveyed, 37 were male, 36 were female, and three were diverse. 55% reported being between 18 and 25 years old, another 40% were between 26 and 35 years old, and the remaining 5% did not specify. About 55% of the survey participants already graduated with a bachelor's degree. Half of the participants (38) were studying in the field of natural sciences and engineering, followed by 20 students in economics, five students in social sciences, and 13 others scattered among other fields. Almost 70% of the exchange students self-reported German language proficiency between B1 and B2 according to the European Framework of Reference (CEFR, 2001).

Context & Learning Environment: All respondents traveled to Germany to study without their families. 73% reported learning predominantly from their home and 23% chose to study in the library. The majority prefers books as a learning medium, with some respondents favoring videos. 57% say they study particularly intensively before exams and otherwise only study a little in the morning before or in the evening after lectures. These findings might be helpful to reveal locations and time frames the eLC should focus on.

Problem Areas in Learning: In order of descending frequency in the mentions, the respondents address problem areas in learning as exchange students overlapping with literature (cf. 3.1): language barriers, lack of networking with other students in the host country, lack of basic knowledge to understand the course content, speed of lectures, lack of motivation, difficulties with their time management and unfamiliar teaching and examination formats compared to the home country.

Needs for Learning Support: The survey participants repeatedly addressed the need for social interaction, support for effective and at the same time relaxed learning atmosphere, help in communicating in the foreign language, and an individualized response to their own learning needs (cf. Table 2).

Expectations of an eLC: Exchange students envision the eLC as a virtual companion that is easy to use and can be designed by the user in terms of appearance and communication style. It should help find solutions to learning tasks, link to learning resources, and facilitate interaction in German as a foreign language through

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supportive functionalities. The survey revealed 15 URs for the eLC design, which are illustrated in the following Table 2.

Table 2: User Requirements for eLCs

User Requirements 1-8 *The eLC should...*	User Requirements 9-15 *The eLC should...*
UR1 have social features to network and learn collaboratively.	**UR9** be a benevolent but not too intrusive reminder of learning.
UR2 play sounds that foster relaxation in the learning process.	**UR10** regularly update its content to stay relevant.
UR3 offer relevant and up-to-date study content.	**UR11** offer a translation feature to facilitate real-time communication.
UR4 help find literature and other relevant content to achieve learning goals.	**UR12** create a positive User Experience and Interface (UX/UI) for easy and enjoyable usage.
UR5 help improve German skills and adapts to progress made over time.	**UR13** contain both, text- and speech-based communication features.
UR6 protect personal user data.	**UR14** have adaptable avatar & voice.
UR7 help with organizing features and time management.	**UR15** adapt interaction automatically to learner's language level.
UR8 act like a friend.	

3.3   Derivation of Design Principles

Building on the 14 LIs and 15 URs, 16 DPs were derived to extend the prescriptive design knowledge to help international students overcome their problem areas in learning while studying abroad in a foreign language. The following table organizes the derived DPs along the five categories previously introduced on page 6 and extends them with a sixth dimension that forces the specifics for non-native speakers. In addition, each DP is assigned its associated LRs and URs in the back columns of Table 3.

Table 3: Design Principles for eLCs

Dimension	Design Principle (Designers should...)	LR	UR
Humanoid Design	**DP1** design an anthropomorphic character that can be adapted as an avatar according to the user's preferences.	1	14
	DP2 design an LC that recognizes emotions and empathizes with the user.	3	
Communi-cation	**DP3** ensure intuitive communication of the LC that adapts to the user's communication style.	4;5	3
	DP4 embed text-based or speech-based communication options to be selected.		13
Interaction	**DP5** offer relevant and high-quality content with users in online courses.	6	7;9;12
	DP6 foster a vivid interaction via animated avatar mimic & gestures.	7	12
	DP7 design an LC that communicates proactively according to the learner's context.	8	4
Ethics	**DP8** ensure (data) security and embed privacy settings to build trust.	9	6
	DP9 consider social & ethical values when developing and implementing the LC.	10	
	DP10 foster autonomy, fairness, and well-being of its with encouraging and inclusive language and a caring attitude of the LC.	11	
Human-Computer - Relation	**DP11** make use of AI-enhanced features for real-time adaptation of the LC resources.	12	10
	DP12 encourage social interactions via features that connect students with peers.	13	1;8
	DP13 set a pleasant learning atmosphere according to the user's needs (e.g., white noise).	14	2
Specifics for Non-Native Speakers	**DP14** implement automated language level recognition and progressively adapt communication of the LC.	2	15
	DP15 offer multi-language settings and embed exercises and feedback to improve the user's foreign language skills.		5
	DP16 translate course content in real-time to support the learner in following a lecture.		11

In the next step, the still abstract DPs were transformed into concrete design features and discussed in a digital co-creation workshop with six Chinese students and the research team, resulting in an expository instantiation.

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3.4   An Expository Instantiation of an eLearning Companion

Using the software *Figma*, an eLC mock-up called "*Study Buddy*" resulted as an expository instantiation. In Figure 2, selected screenshots of the conceptual prototype are shown, where the implementation of DPs 1-16 is indicated by labeling the respective **design features** (DFs).
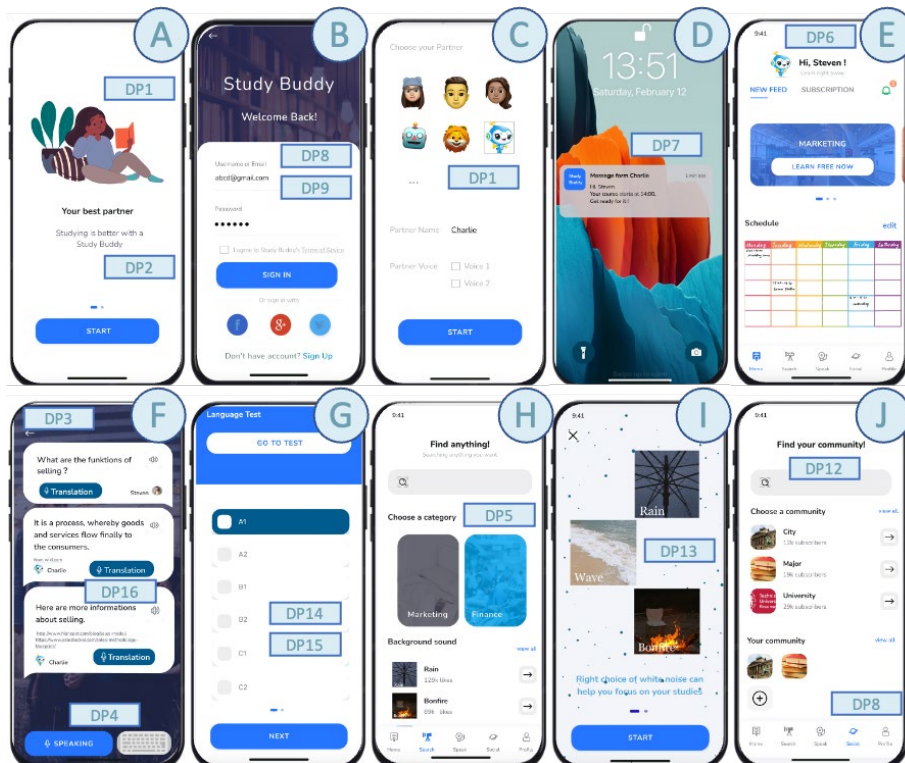

Figure 2: Prototypical Screens (A-J) of the Expository eLC

Screen A shows a human character **(DP1)** whose representation (e.g., fashion, context, and current activity) adapts to the learner based on the shared information **(DP2)** or can be further customized according to user preferences, for example, by changing the avatar and its voice **(screen C)** to represent diversity in the most non-discriminatory way possible and to enhance the learner's well-being **(DP9+10)**.

Screen B shows the encrypted, password-protected log-in of the app. In the settings, further privacy and data management choices (e.g., incognito mode, viewing and deletion functions for the user) can be selected **(DP8)**. On **screen D**, the eLC proactively reminds the user of an appointment **(DP7)**, then visualizes the timetable in **screen E** and motivates the user to study regularly with encouraging language and appropriate gestures from the avatar **(DP6)**.

Screen F shows an excerpt from an intuitive, natural language communication that determines the communication style of the learner **(DP3)** and the learner's mood in the backend (e.g., through sentiment analysis) and reacts to this in a context-based manner **(DP2)**. Thus, the eLC is perceived as a social actor with its own personality and builds a trusting relationship with the human user. The learner can communicate with the eLC both text- and speech-based **(DP4)**, with real-time translation features designed to permanently help the user follow the communication **(DP16)**. There is an automatic adjustment of the language level **(DP14)** or the users can specify it themselves **(screen G)** to initiate exercises and feedback for foreign language skill improvement **(DP15)**. **Screen H** shows learning material relevant to the user's learning goal **(DP5)**, with the associated resource library to be regularly adapted, for example, enabled by artificial intelligence **(DP11)**. A positive learning atmosphere **(screen I)** is created through selectable background noise (e.g., white noise) **(DP13)**. Different groups in a common communication space **(screen J)** encourage social networking with the peer group (e.g., with similar language level or the same major) **(DP12)** to promote collaborative learning while ensuring ethically responsible behavior and legal compliance **(DP8+9)**.

The instantiation was iteratively evaluated by presenting it to interdisciplinary researchers and other students from the host university in the form of presentations (after steps 3, 5 and 6) followed by intense discussions. Furthermore, the prototype presented here was evaluated with 16 (mainly international) students by reflecting the proposed DPs and DFs and their fit to tackle real problems in studying abroad. The versatile features met with approval, although individual design recommendations (e.g., the anthropomorphic design) were discussed controversially, similar to the literature (e.g., Feine et al., 2019; Lester et al., 1997; Moyle et al., 2019), which is why the prototype also offers non-human alternatives **(screen C)**. The DFs for overcoming the language function were rated as particularly important, with students emphasizing that incentives should be provided

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to continually improve language skills - for example, through a reward system for unlocking interesting additional features. The discussion with students from different countries of origin also revealed cultural differences needing further investigation - for example, in terms of expectations of communication style (e.g., formal vs. informal) in an educational context.

4   Conclusion

In addition to a multitude of design-oriented studies on PCAs, also with a focus on language learning and the awareness that they could revolutionize digital learning, the use case of supporting foreign-language study abroad students in literature comes up short despite globally growing university internationalization efforts (de Wit & Altbach, 2021). Therefore, in our paper, we presented initial findings on how to derive actionable design knowledge for the design of eLCs to support this target group, based on scholarly literature and from the perspective of Chinese-speaking visiting students during their academic stay in Germany. We documented 14 LRs and 15 URs based on the results of an online survey with 76 surveyed Chinese students at a German university. As a result, we derived 16 DPs and classified them along the dimensions of humanoid design, communication, interaction, ethics, human-machine relationship, and specifics for non-native speakers. Our findings reveal novel insights for designing eLCs for exchange students and potentially other similar audiences. We provide researchers and practitioners with the design knowledge gained for eLCs, as documented in Tables 1-3 and the expository instantiation, so that they can ensure a problem- and user-centered development of eLCs. Furthermore, major advances in technology (e.g., NLP and ML) and internationalization intensifications in academia may encourage more exploration and implementation of these innovative eLCs (Thakore, 2021; Wu et al., 2019). We seek further instantiations and empirical evaluations of our generated design knowledge to contribute to a nascent design theory in information systems (IS). Thus, we hope to encourage designers to focus more on specific use cases of PCAs in general and eLCs with large potential user groups, such as non-native (exchange) students in particular.

However, our research is also subject to limitations. Since our goal was to derive practical DPs to support developers, the IS perspective dominates. Additionally, the empirical survey was conducted at a German university with exchange students from

one country, China, in their native language, so it is not certain whether elicited requirements are culture- and region-specific. Besides it remains unclear, whether the design knowledge is also applicable to other target groups (such as refugees integrating into new learning environments) facing some similar challenges, but also have to cope with specific ones. Therefore, the transferability and adaptation of the findings to other use cases and country combinations for the host and home country yet need to be investigated. Likewise, a different selection of literature or a differently posed questionnaire might influence the design knowledge, which is why our explicit goal is to encourage further discussion and research. Overall, our paper contributes to a better understanding of the needs of international students and how they can be supported by eLCs as a form of technology-enhanced learning in academia.

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