REFLECTION OF INDIVIDUAL COGNITIVE LOAD THEORIES IN DIGITAL LEARNING FROM A PEDAGOGICAL POINT OF VIEW – AN EMPIRICAL STUDY OF THE IMPACT OF LANGUAGE SKILLS IN AN E-LEARNING PROGRAM FOR MIGRANTS AND REFUGEES

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Abstract.Cognitive Load Theory (CLT) and the Cognitive Theory of Multimedia Learning (CTML) deal with the thesis that human working memories can only store and retain a limited number of items and address how to utilize individual capacity in the learning process without provoking cognitive overload. Based on these theoretical insights, traditional ways of non-digitalized learning are usually perceived to be more effective, as there may be less cognitive overload due to digital multimedia design; however, with the use of modern technology, digital educational offerings such as e-Learning programs can be effective as modified and tailored to the learners' needs. This article studies how language barriers can negatively impact the success of e-Learning programs for migrants and refugees from the perspective of CLT and a pedagogical point of view.

The theoretical framework of CLT and CTML applied to interpret the findings from empirical data collected as part of the EU-funded project "Young Refugees AI Student Empowerment Program – RAISE." The project aims to capture the participants´ experiences and cognitive skills by shaping pedagogical strategies that adjust to the learner's optimal pace and learning needs. The study explores the structural requirements of e-Learning programs for migrants and refugees based on Cognitive Load Theories. The baseline is that e-Learning is complex and demands significant working memory resources. This effect is significantly elevated to a point where it harms learning when the external demands vastly exceed the corresponding cognitive working memory resources.

Keywords: Cognitive load theory (CLT), Cognitive Theory of Multimedia Learning (CTML), e-Learning, language skills, migrants and refugees

Introduction. Language is a highly complex system mainly used for communication and is key to social integration in a multicultural context [1]. In the educational context, language also holds significant importance as it serves as a medium for education and the skill to understand a subject first and then be able to read, write, speak, and listen in the context of knowing the language [2].

Therefore, language plays a crucial role, particularly for migrants and refugees, in terms of individual, societal, and labor market integration, making linguistic competence in the host country's language essential for their new belonging to a country [3]. It "is considered one of the most central aspects for migrants' inclusion by both the receiving society and migrants themselves [4, p. 174].

However, learning new things by storing and processing in the personal working memory in a non-native language often causes challenges in the learning process as "complex life circumstances" [5, p. 122], such as difficulties in language comprehension, coordination issues, and cognitive overload arise.

The EU-funded project "Young Refugees AI Student Empowerment Program – RAISE," launched in 2022, aims to provide migrants and refugees with opportunities in the European job market and support their social integration (Erasmus+, 2021). Through the e-Learning program "Youth Volunteer Educators e-Learning Program - e-VELP," immigrants and refugees can acquire skills to conduct workshops on various topics, which are intended to enhance their employment prospects through host organizations [6]. The learning program is divided into five chapters with thematically different units that prepare participants to create didactically high-quality workshops. Depending on the topic of the chapter, participants learn relevant concepts that are fundamental to be able to subsequently share their thematically independent skills and culture with other people in the form of an online workshop. Table 1 provides an overview of the five chapters.

Table 1 - Structure of the e-Learning program e-VELP

Chapter	Title	Learning goals
Chapter A	Identify your skills, knowledge, and attitudes	1. Learn how the attitudes you adopt influence your ability to increase knowledge. 2. Learn about the interconnection between your attitudes, knowledge, and skills. 3. Learn how to assess your own skills.
Chapter B	Develop your pedagogical skills	1. Know yourself as a learner, and learn about self-directed learning. 2. Explore yourself as a self-directed learner and develop a learning plan. 3. Knowing about self-reflection and self-evaluation.
Chapter C	Enhance your communication and intercultural skills	1. Learn about culture-related concepts: culture, diversity, cultural knowledge, encounters, etc. 2. Learn about the role of cultural knowledge and the importance of cultural encounters in everyday situations. 3. Understand cultural stereotypes, prejudices, and culture shock.
Chapter D	Develop your marketing and networking skills	1. Use social media in your VE [Volunteer Educator] journey in order to engage people. 2. Find and communicate with a host organization. 3. Promote your workshop to the public.
Chapter E	Plan and execute your workshop	1. Learn how to structure your workshop into phases. 2. Learn about different methods you can use during your workshop. 3. Execute your workshop. 4. Learn how to write a story about your workshop. 5. Learn how to promote your story and expand your impact.

The follow-up project RAISE builds upon this digital learning program by optimizing the existing learning offering by addressing known deficiencies through AI technology [7]. It is still aimed at the same target group of migrants and refugees, aged 18-30, in Europe who want to integrate into a new country long term and are intrinsically motivated to participate socially and to find a profession that matches their skills.

Based on evaluations of the original program e-VELP, the following difficulties have already been identified [8], which have to be adjusted for the target group:

• It is not personalized or tailored to the participants' didactical needs in terms of the cognitive load imposed by language skills.

• The scope is too large and, therefore, takes too much time.

• There is no possibility to ask questions or exchange with other participants independent of the learning content of the e-Learning program.

• It is only realizable in English and, therefore, a necessary condition for participants to understand English.

• The content layout is complex and based mainly on texts that must be read.

• The to-be-learned pedagogical and psychological concepts are challenging and need to adjust to the target group

In addition to improving personalized adjustments for users through a customized learning plan, structural changes have to be made to make the digital learning process more intuitive and with better time efficiency. Specifically, regarding participants' information processing, linguistic modifications will be implemented to minimize cognitive load and conserve the mental resources in their working memory. The aim is to provide the participants with a resource-friendly learning process using an adapted layout, in which only a small amount of cognitive load in the working memory has to be used for the comprehension of the materials, the translation process from English into the particular native language and the information processing, so that as much capacity as possible of the individual load in the working memory remains available for the actual learning process.

For theoretical optimization, two widely used cognitive load theories will be presented in the following, which form the basis for the empirical pilot survey study that we conducted and report in this paper. The study's research question and the main goal will be presented, exemplifying how the linguistic conditions of the migrants and refugees in the e-Learning program can be related to the cognitive load during the learning process. Expectations for the study results come afterward, and the methodological approach is explained, followed by the results and the discussion, in which the central outcomes are interpreted, combined with the previously mentioned CLT and CTML. Finally, suggestions for future research are offered.

The following study aims to determine how migrants and refugees are impacted by using a foreign language in e-Learning programs. It tries to identify aspects that can be optimized in e-Learning programs to provide target audiences with a resource-friendly learning experience without a cognitive overload based on the CLT and CTML.

Theoretical background

Basics of Cognitive Load Theory

The Cognitive Load Theory (CLT), developed by John Sweller in the 1980s, is based on the idea that the human working memory has capacity limits during knowledge acquisition and is, therefore, not unlimitedly available for new information input. Instead, the theory assumes that learning depends on individual working memory resources and the extent to which sufficient capacity is available [9]. This means that every learning process is associated with cognitive effort, and information processing only occurs if capacity is available in the

working memory. The following insights can describe the functioning of mental memory [10]:

- Humans have virtually unlimited long-term memory.
- The human working memory can only process a limited amount of information.
- Knowledge representation occurs in schemes that are either already existing (prior knowledge) or need to be newly constructed.
- The working memory has an organizational function, allowing metacognitive processes such as problem-solving or information processing to be actively controlled.

The theory distinguishes three different types of cognitive load on the working memory:

1. Intrinsic Cognitive Load: Intrinsic load refers to the cognitive load that arises from the materials and interactivity of the individual content to be learned during the learning process. It concerns the complexity of the subject matter and the processing of elements that need to be simultaneously maintained in the working memory. This cognitive load for the learner often depends on their prior knowledge of the content or elements to be learned since complex concepts can be easily integrated into existing schemas with high prior knowledge. On the other hand, individuals with low prior knowledge must maintain a significantly more significant number of elements in their working memory, which is demanding.

2. Extraneous Cognitive Load: Extraneous load refers to additional cognitive demands that impede knowledge acquisition due to the suboptimal design of the learning materials. This so-called irrelevant cognitive load depends on the presentation format and should be kept minimal, especially when the intrinsic cognitive load is high due to content complexity.

3. Germane Cognitive Load: This load arises from active engagement with the learning content and is closely related to the previously mentioned source of cognitive load. It concerns the resources of the working memory that need to be utilized to cope with the internal cognitive load. The more resources are required for the learning process, the fewer resources remain available to handle the actual load imposed by the learning materials.

Individual cognitive support measures can unlock the remaining potential if the sum of cognitive loads is not fully utilized. This can be realized by varying teaching materials in format, i.e., allowing texts, images, animations, and videos to address other cognitive loads. When different representational forms are used, learners can decide freely how to assimilate the information best to achieve a deep understanding of the thematic content.

In summary, CLT above follows the "less is more" approach [11] and advocates avoiding unnecessary materials, content, and designs, especially in the design of learning materials. Furthermore, it becomes clear that a direct approach regarding knowledge transfer is always advocated. According to Sweller, concepts such as "discovery learning" [12] or "experiential education" [13] are not realized to keep the cognitive load as low as possible. Sweller observes that the materials may be inadequately designed when analyzed in terms of motivation and learning performance. Nevertheless, the theory can be evaluated as broadly accepted since numerous empirical findings have backed it up [14].

Basics of the Cognitive Theory of Multimedia Learning (CTML)

The theoretical findings on the importance of multiple levels of representation are also supported by the CTML, which, in addition to the previously explained theory, provides another approach to describing information processing in the working memory [15]. The focus of this theory explicitly lies in the processing of multimedia learning materials through different modes of representation and the storage of knowledge through mental models. That means that Multimedia Learning is defined as the process "when people build mental representations from words (such as spoken text or printed text) and pictures (such as illustrations, photos, animation, or video)" [16, p. 1]. Based on Mayer's idea that information

processing through texts and images is a multi-stage process, various principles can be derived:

- The information processing system has two channels for short-term storage and organizational processes: visual/pictorial information and auditory/verbal information. The visual and verbal models must be activated and related through integration processes for a deep understanding.

- The channels in working memory do not have unlimited capacity to process information. Therefore, when presenting materials for the learning process, the number of information elements should be considered to avoid cognitive overload for learners.

- Active information processing is necessary during the learning process to construct the learning object coherently and relate it to other mental models.

Referring to the CLT, instructional materials must be designed so that the capacity of the two channels does not lead to cognitive overload for learners. The capacity limit is individual and can occur during knowledge information selection, organizational, or integration processes 17]. Thus, the CTML also continues the "less is more" idea to burden the working memory as little as possible due to the design of the learning materials. However, the same attitude towards discovery learning or experimental education concepts is not advocated. Nevertheless, this theory can also be evaluated in large parts as a differentiated theory from which numerous recommendations for designing multimedia learning units can be derived. Further, it must be emphasized that experimental reviews are sometimes highly inconsistent and that, for the most part, only theory-supporting findings are used in review articles.

The theoretical approaches show the relevance of considering the cognitive resources in the learners' working memory when creating learning materials. Especially in the context of the target group of migrants and refugees, there is a risk of cognitive overload since the foreign language has to be considered in addition to the actual learning process. This raises the question of the extent to which understanding the content, materials, and task requirements in a foreign language (here: English) already exhausts the resources in the working memory and how much capacity remains for the actual transfer of knowledge.

Considering the theoretical findings, it can be discussed that the known challenges of the presented e-Learning program, especially the intrinsic and extraneous load, can influence the learning process of the target group. On the one hand, it is about the complexity and the amount of content, which is part of the intrinsic load. On the other hand, it seems that the extraneous load is high, even considering the theoretical findings of the CTML, because the way the course was designed is not personalized. Therefore, no consideration of the participants' language ability was considered. Furthermore, it turned out that the content layout can be demanding, especially considering, according to Mayer, that the working memory has limited capacity and consists of two channels, both of which have to be fed with information to create a deep understanding. In the e-Learning program e-VELP presented, the channel for verbal communication is predominantly addressed, so the channel for pictorial processing is neglected. This also results in a high germane load for the target group since the working memory resources are already needed to understand the content during the learning process.

This paper examines this particular challenge by reviewing a survey conducted as part of the RAISE project, which analyzes the impact of language barriers and cognitive overload on the success of the learning progress in an e-Learning program. Therefore, a research question and its objectives are defined, later closely analyzed, and compared with the previously introduced theories.

Main Provisions

The empirical study investigates the application of the aforementioned theories within the context of the e-Learning program, with a specific pedagogical focus aimed at identifying potential structural enhancements. This enhancement primarily involves linguistic simplifications and the integration of interactive elements. The central objective of this study is to discern how participants perceive deficiencies related to these two theories, ultimately pinpointing ideas and processes for reconfiguring an existing e-Learning program. This leads to the following research question for the empirical study:

How do language skills impact the success of an e-Learning program for migrants and refugees?

Expectations

As the target group (migrants and refugees, ages 18-30) was highly heterogeneous and small, many aspects and influence factors had to be considered; the expectation was that the results will be very mixed as the participants come from various regions and have different cultural and educational backgrounds. Furthermore, the e-Learning program uses complex academic language, and the content is challenging, so we also expected many participants to provide feedback on certain deficiencies already known to us, e.g., the program being too extensive, the learning units' content being very long, and the pedagogical concepts needing to be revised for their purposes.

Regarding the requirements, we expected feedback that they are too complex and complicated for many migrants and refugees whose native language is not English, potentially leading to confusion, loss of motivation, and even discontinuation. The program may also need more support measures or opportunities for interactive exchange, especially by participants with limited English proficiency or those using the online program to communicate with others. On the other hand, the program conceptually did put a significant focus on considering the various cultural backgrounds, something that we expected to be positively acknowledged. Additionally, participants may mention that the e-Learning program handles cultural contextualization sensitively and that the content has been selected precisely.

Materials and methods

The survey assesses the use of the perception of language complexity and language comprehension concerning the learning units' questions, tasks, and content. The data collection is based on a digitally designed survey conducted in May 2023, consisting of 14 questions, 12 closed-ended and two open-ended questions. The closed-ended questions structure the study and obtain clear statements regarding the research topic. In contrast, the open-ended questions allow participants to express individual aspects and thoughts that the other questions may not cover. Based on the participant's L1, the online questionnaire was conducted in English and then translated into Arabic, Turkish, Greek, Spanish, and French based on the target group's native languages. This procedure was intended to ensure that all participants in the evaluation study understood the questions correctly and could articulate themselves adequately.

The first section (questions no. 1-5) includes demographic questions to gather information such as age, country of birth, first language, and other language competencies, which will be considered during the analysis. In the second section (questions no. 6-7, 11-12) are questions regarding self-assessment of language comprehension, in which participants rate themselves on a scale of 1-10 or 0-100% (depending on the question). This is followed by tasks and questions (questions no. 8-10) to find out the most challenging aspects on, the one hand with predetermined answer options and the option to provide a written response, and on

the other hand, a free text task, in which the participants have to find their own words. The final section (questions no. 13-14) aims to determine the participants' motivation and identify suggestions for improvements that participants may have regarding language usability. Table 2 provides an overview of the questions we asked in the second and third section of the questionnaire.

Table 2 - Structure of the questionnaire

No.	Question	Question format
6	How well did you understand the tasks and questions of the program in English?	Rating 1-10
7	How well did you understand the content of the program in English?	Rating 1-10
8	Have language barriers led to not understanding the program?	Yes/No
9	Which aspects were the most challenging?	Multiple Choice
10	Please explain in your own words the most challenging aspects of the program regarding the language complexity.	Free text
11	How much of the whole content did you understand?	0-100%
12	Did you use translating tools to learn?	Yes/No
13	Did you lose your motivation to continue because of the language complexity?	Yes/No
14	What would help to understand the tasks and content of the program better?	Free text

Respondents

A total of 36 participants who had already registered for the e-Learning program and started their learning process were invited to participate in the study by receiving a digital link via email. Ultimately, 15 students (41%) in age from 20 to 38 years participated. At the time of the study, nine participants were at least 30 years old, making up the largest group with 60% representation. Regarding the birthplaces of the participants, it is evident that they form a highly heterogeneous group in terms of their home countries, with only 13% of the participants sharing the exact origin. Nigeria and Nepal are represented twice each, and the countries Italy, China, Morocco, Bangladesh, United Kingdom, Afghanistan, Singapore, Turkey, Azerbaijan, and Chile are each mentioned once. As a result, the participants' native languages are also highly diverse. Among the 15 participants, 11 languages were mentioned as their mother tongues. The Nepali language was mentioned twice as a native language, and three participants indicated that they learned English as their first language, which will be interesting for the subsequent interpretation of the results. Figure 1 illustrates the self-assessment of English language proficiency:
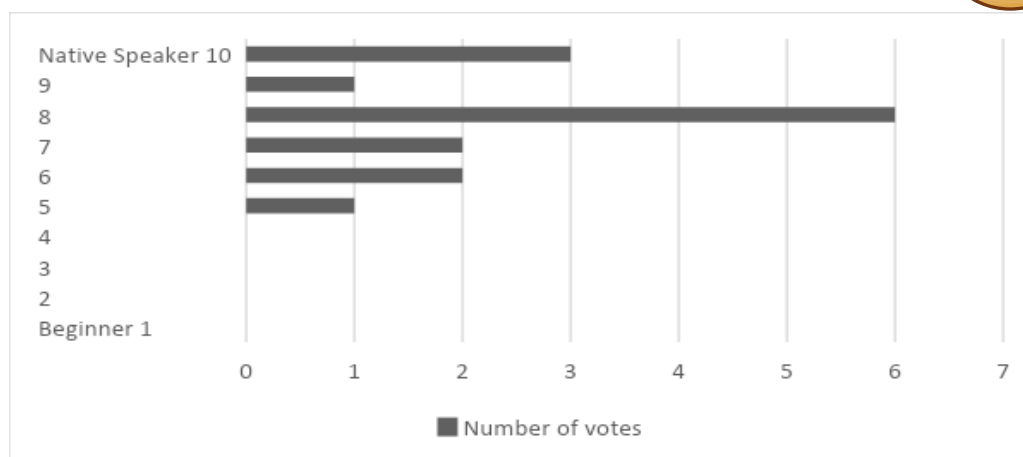
Figure 1 - Self-assessment of English language skills

All respondents rated their English proficiency on a scale of 1-10 as ≤ 5, with 1 being described as "Beginner" and 10 as "Native Speaker." 20% of the participants rated their English proficiency at the level of a Native Speaker (10), and these are also the individuals who indicated that English was their first language. 46% of the participants rated their English proficiency as an 8 or 9 on the scale, clearly in the upper third of the self-assessment range. Two (13%) of the participants rated their English proficiency as a 6, and another two (13%) rated it as a 7, both of which are also in the upper third of the scale, suggesting that these participants have solid language skills. Only one participant rated themselves as a 5, representing this survey's lowest self-assessment. The presentation shows a clear result regarding self-perceived English proficiency: None of the participants rated their language skills below five on a scale of 1-10, but rather in the upper ranges, which are much closer to the assessment of "10 = Native Speaker" than "1 = Beginner."

For the following analysis of the results, four cohorts are formed to be able to cluster the answers of the target group. The basis for this are the language skills self-assessments, which were mapped with the question, "What do you think: How well do you speak English?".

<5 → limited language skills
5-6 → moderate language skills;
7-8 →good language skills
9-10 → native language skills

Due to the small number of participants (n = 15), we conducted a descriptive analysis, indicating frequencies and averages. The survey is an initial pilot study to assess the question guide's suitability in practice and gain valuable insights for our future work from a pedagogical point of view.

Procedure

The analysis is based on the responses of all participants. Using the categorization of open-ended questions following the scheme of Kukartz's content-structuring analysis (2018), the results will be presented as comprehensively as possible and related to the results of the closed-ended questions. Descriptive calculations of frequency distributions between individual questions were used to ensure a holistic survey analysis. This analysis was conducted using Excel (Microsoft).

Due to the small number of participants, the categorization process followed the sequence [18]:

- Reviewing the responses
- Coding the entire material according to the created main categories

- Developing main thematic categories
- Visualizing and analyzing the data

Thus, the answers to question 10 and 14, were are sifted and assigned to different categories with the help of content analysis by combining all similar answers and emphasizing the same statement. After the materials had been coded, the respective main categories were given titles (for instance, no suggestions for improvement; more examples; reduction of complexity). We also noted which thematic connections the various categories have, and to what extent they differed. Afterward, the data could be quantified and presented in a visually appealing way with the help of tables and figures (see Table 3, Figures 2 and 3).

Results

Representation of selected results regarding language comprehension within the e-Learning program (questions 6-8, 11-12)

The self-evaluation results show: All participants have a moderate to perfect understanding of both the question and task formats and the content, with no significant difficulties in comprehension or other language barriers. Regarding whether language barriers hindered their understanding of the content during the learning process (question 8), there is also a clear result: 86% of the participants answered with "No," indicating no language barriers and, therefore, no comprehension difficulties. Only 14% of the participants answered "Yes" to the question. The evaluation of the question regarding the percentage of content understood (question 7) confirms the results above. According to self-assessment, 46% of the participants understood 100%, and 54% understood 75%, which was the next lower option. In combination with the comprehension questions, participants were also asked whether they used aids translating tools (question 12). The evaluation shows that 60% of the participants answered "No" to this question, indicating they did not use any aids. Consequently, 40% of the participants used aids. This result also shows that most did not require aids to complete the e-Learning program.

Table 3 - Cohort analysis of language comprehension

Evaluation format		Scale 1-10	Scale 1-10	Yes/No	Scale 0-100%	Yes/No
		Task clarity (question 6)	Content comprehension (question 7)	Language barriers (question 8)	% of content understood (question 11)	Use of translating tools (question 12)
Cohort 1	9-10	10.0	10.0	0%	94%	0%
Cohort 2	7-8	8.75	8.88	50%	88%	63%
Cohort 3	5-6	8.3	8.6	67%	75%	33%
Δ1-3		1.7	1.4	67%	19%	33%

While the analysis indicated relatively strong overall language comprehension skills, a further cohort analysis showed clear differences in language skills and its implications on the ease-of-use of the e-Learning among the participants. Table 3 shows the averages within the three cohorts for the five most relevant survey questions concerning language comprehension.

The results through cohort formation show that especially the individuals who previously rated themselves best (9-10 = native language skills), compared to the other participants of other cohorts, also indicated in the questions on language comprehension that they had no difficulties at all in understanding the tasks (1) or content (2) and likewise that there were no language barriers that were critical for the lack of language comprehension and that aids such as translating tools were used to help them. With an average score of 10.0 for the two categories, "Task clarity" and "Content comprehension," and 0% for the categories "Language barriers" and "Use of translating tools," all participants selected the highest possible choice on a scale of 1-10 and 0-100% respectively, which again can be attributed to the level of a native speaker, similarly, concerning the cohort. For this cohort, 94% of the content was understood compared to the other participants the most.

Good average scores can still be formed for the second cohort group (7-8 = good language skills). 8.75 and 8.88 points of the two categories "task clarity" and "content comprehension" also correspond to the cohort formation of these participants. Thus, the participants rate themselves between 7-10 on the scale, which is also evident in the yes-no categories "language barriers" and "use of translating tools." There are mixed results, which can nevertheless be positioned in the upper range of language comprehension: 50% of the participants within the cohort state that they have, on the one hand, experienced and, on the other hand, not experienced any language barriers. 37% of the people have not resorted to any tools, and 63% used translation tools. In total, 88% of the entire content was understood by the participants of this cohort.

The third cohort (5-6 = moderate language skills) has the lowest results compared to the other two. Averages of 8.3 and 8.6 in the categories "task clarity" and "content comprehension" still show above-average results compared to the cohort assessment based on their self-assessment of how well they speak English. Nevertheless, it is evident that in this group, with 67%, there are the most participants who reported having experienced linguistic barriers and that all learners understood a maximum of 75% of all content. Surprisingly, despite language comprehension difficulties, only 33% used translation tools, and 67% of this cohort did not use any tools.

Based on the findings described above, there are significant differences between the first (1) and third (3) cohorts (please refer to the last row in Table 3): Cohort 1 is, on average, 1.7 and 1.4, scoring points higher, which means they understand the tasks and content of the exemplary e-Learning program better. Regarding the third category, "language barriers," it becomes clear that the first cohort has 67% fewer language comprehension problems due to barriers than the third cohort, with the participants who initially reported the lowest language skills. Moreover, in the following category for the percentage of content understood, it seems logical that cohort 3 understood 19% less than cohort 1. When comparing the two groups, the results also show that 33% more of the last cohort used translating tools.

The implications of potential e-Learning successes of those different language comprehension levels will be assessed in the discussion.

Representation of selected results regarding the most challenging aspects during the learning process (questions 9-10, 13-14)

After analyzing the self-assessments regarding language comprehension, the next step is to investigate which aspects of e-Learning are most challenging for the participants based on their English language skills. A multiple-choice question (question 9) with predefined answers was evaluated to address the question of which aspects were most challenging based on individual language comprehension. Four of the answer options were predefined, and there was an additional option, "Others," to write an answer freely:

1. To understand what I have to do.
2. To read the very long texts.
3. To articulate yourself in free text tasks.
4. To stay motivated even though the language was very complex.
5. Others

These answer options were based on feedback from previous evaluations of the original project [8] and aimed to allow participants to answer the question without writing their responses. They had the choice to select multiple answers, which 26% of the participants utilized.
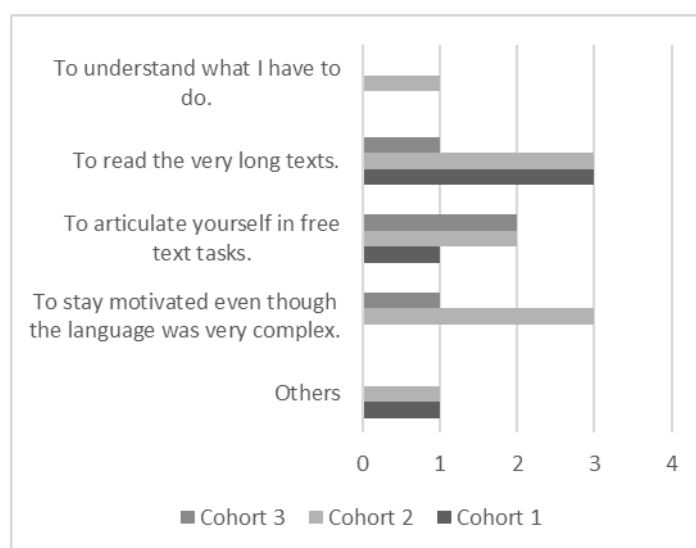
Figure 2 - Cohort analysis of the most challenging aspects of e-Learning

Figure 2 illustrates the distribution of a total of 19 responses. It is evident that reading the long texts (2) was the most challenging aspect of the e-Learning program for 36% of the respondents while articulating oneself in text formats (3) was the most challenging aspect for 25% of the respondents. These two answer options were selected the most frequently, especially for cohort 1 with native language skills and cohort 2 with good language skills for the articulation in free text tasks.

Three (21%) of the total responses and, for the most part, from cohort 2 indicate that staying motivated in the face of the complex language of the e-Learning program was the most challenging aspect. However, considering the previous evaluation, it can be observed that the individuals who selected this answer option rated themselves with ≤8 out of 10 in terms of language proficiency in the other questions, and 75% of these individuals indicated that there were no language barriers affecting their language comprehension.

Only one person found in cohort 2 was attributed to the answer option "to understand what I have to do." This suggests that the requirements were precise, and the respondents knew what to do during the learning process. These results align with the findings of a previously discussed question, where 46% of the participants claimed to have understood all the content, and the other participants rated themselves in the upper third of the scale.

Regarding the evaluation of the "Others" responses, the answers account for 10% of the responses and refer to either the technical complexity based on an answer from cohort 1 or the fact that the person (from cohort 2) had not previously conducted workshops and therefore finds it most challenging to offer their workshops based solely on theoretical content.

Subsequent to the question, it was also surveyed what options would help to reduce the difficulty of the learning process based on the language comprehension problems. The question "What would help you to understand the tasks and content better?" (question 14) was also created to present the thematically relevant statements in a structured manner:

- more examples
- reduction of complexity
- no suggestions for improvement

All categories were created based on the participants' statements. The following diagram shows the frequency of keywords assigned to each main category per person. Conclusions can be drawn from the frequency of thematically related statements to interpret the results and determine the relevance of the categories for practical implementation afterward.
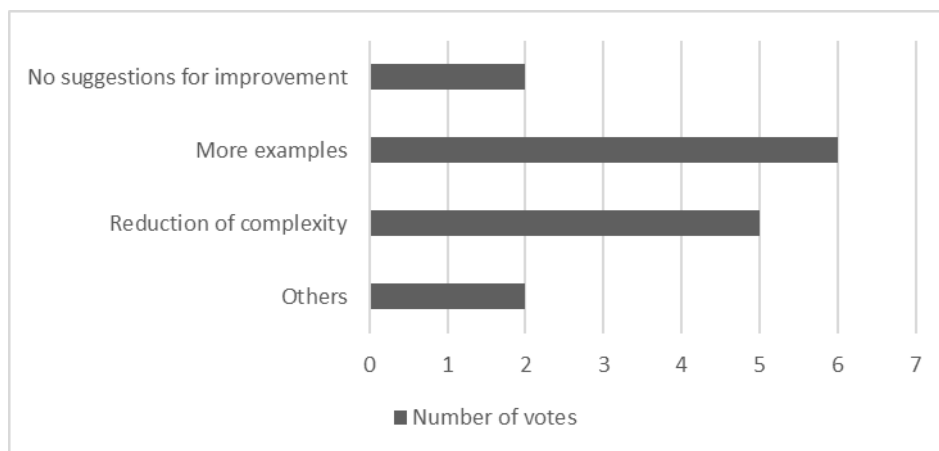
Figure 3 - Optimization suggestions based on the participants´ votes

The following results emerge from the distribution: The category "No suggestions for improvement" can be found in 13% of all responses. The category "More examples" covered the largest share, with 40%, followed by "Reduction of complexity," which is represented by 33%. 13% of the participant's answers could not merge into one of these categories. They included the request for internal translation capabilities stemming from Cohort 2 and the demand for more time and understanding if someone wants to complete the e-Learning program alongside a full-time job and cannot meet the time constraints.

The fact that many text passages in the category "No suggestions for improvement" were found in Cohort 1 is not surprising and broadly aligns with evaluating other results. Exemplary statements such as "Forms and explanation of the content were delivered well," "I did not experience much language complexity," or "I did not struggle with the content," as well as "It was easy to understand and formulate" are clearly from participants who indicated that they learned English as their native language and rated themselves as native speakers with a score of 9-10 on the initial scale. Another particular category, "Reduction of complexity," with exemplary statements from participants such as "I need to see the content clearer" or "Giving more space for superficial words," provide insights into the identified difficulty and are primarily based on Cohort 3 with participants of a moderate language skill assessment.

Based on past language skills and complexities findings, whether the participants lost motivation due to language barriers can be analyzed (question 13). The answers align with the previously presented results. 93% answered the question with "No," indicating that almost all

participants maintained their motivation. Only 6%, found in cohort 2, with a good language skill assessment, responded with "Yes," stating they lost motivation due to language difficulties.

Discussion

The study aimed to assess if and how language skills can affect migrants' and refugees' success in an e-Learning program and, if so, to what extent individual language comprehension might cause challenges to overall learning success. We expected that the participants would rate themselves significantly weaker in terms of their language performance, which would have made it more evident that a majority of the shortcomings of the e-Learning program would be due to language not properly being adjusted to the target group. The results, however, showed that the students self-assessed their language skills significantly better than expected, and based on this, only limited suggestions for optimizing language use can be derived. Participants also reported significantly more interest and motivation and did not perceive linguistic complexity as a significant disadvantage. Instead, it was the amount of text length, the lack of examples, and the meager supply of multimedia learning options.

Comparing cohorts from a pedagogical point of view

The above-explained cohort construction based on the self-assessment of language comprehension shows that especially 75% of the first cohort (9-10) assess themselves as native speakers. In comparison, the second cohort with good language skills includes participants with native languages such as Nepali, Greek, Spanish, and Cantonese. Interestingly, the participants in this cohort indicated that they speak other languages, which reminds us that multilingualism is the norm for most people in the world, including migrants and refugees in this study. The third cohort, with only 20% of all participants the smallest, also includes participants who did not learn English as their first language but Italian, Kurdish, or Azerbaijani, and 33% of the cohort speak no other language than their mother tongue.

Not surprisingly, people who have learned English as their first language have also assessed themselves best in the self-assessment. In contrast, people who have not learned English as their first language and do not speak languages other than their mother tongue assess themselves as weaker than those who have indicated that they can speak other languages. The results show: The target group can obviously be divided into two groups, although most of the demographic factors are comparable. In the case of the study, it becomes clear that one group obviously has more difficulties than the other group, and it can be thus interpreted that language impacts the learning process. Also, the aspects regarding challenging elements in terms of usability become clear: While all participants of cohort 3 did not express that they faced any difficulties, there were still suggestions for improvement to reduce complexity, to include examples, to offer introductory videos, or to shorten the texts. 80% of the statements of cohort 1 thus referred to not having had any language challenges.

The most important insight is that participants with poorer foreign language skills perceived the e-learning program differently than native speakers of the language of the e-learning program. If one relates these findings to the theoretical background presented before, the interpretations can be justified because cohort 1 impacts the learning process differently than cohort 3.

Cognitive load and mental impact

The reason for different impacts can be explained by the structure of working memory [19], and the processing of external stimuli and information. In contrast to long-term memory,

working memory has limited capacity and can, therefore, only process a certain number of information elements simultaneously. In the case of e-Learning, the participant's working memory may be additionally loaded with the task of interpreting and processing content in a foreign language, whereby they need to process the task of interpretation and comprehension simultaneously. According to the CLT, this would have implications on the intrinsic cognitive load for the learners. Depending on the level of prior knowledge, the germane cognitive load will also be massively challenged and influenced by materials not adapted to the target group. This interaction between intrinsic, extraneous, and germane cognitive load are risk factors, especially in cohort 3, that can cause a cognitive overload and strain the working memory massively, which has negative consequences on the learning process. Because the target group of the presented project is highly heterogeneous and, according to the study, has different basic requirements, especially regarding linguistic abilities and knowledge, it seems reasonable to posit that the extraneous and intrinsic load causes cognitive overload.

With this understanding and from a pedagogical point of view on e-Learning for migrants and refugees and the consideration of the above-mentioned insights, we conclude that the inadequate handling of content and materials, the complexity, scope, and learning in a foreign language can provoke a mental overload of the extraneous part of the working memory. Figure 4 illustrates the structural difficulties that may occur:
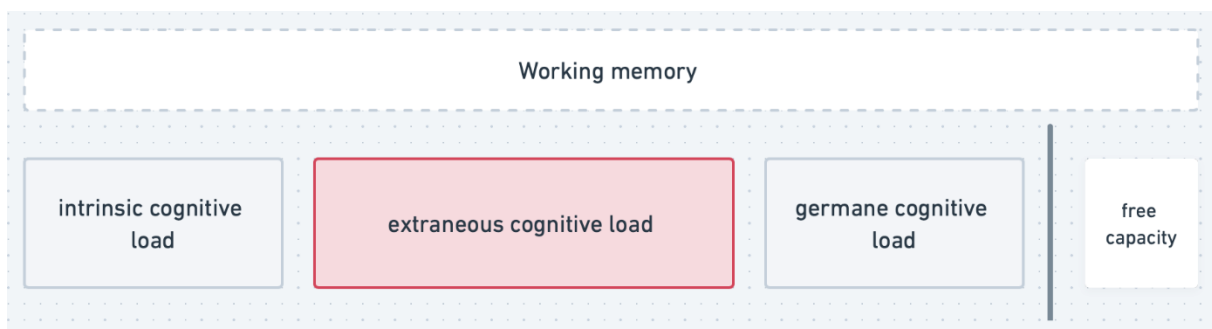
Figure 4 - Structural difficulties in e-Learning programs
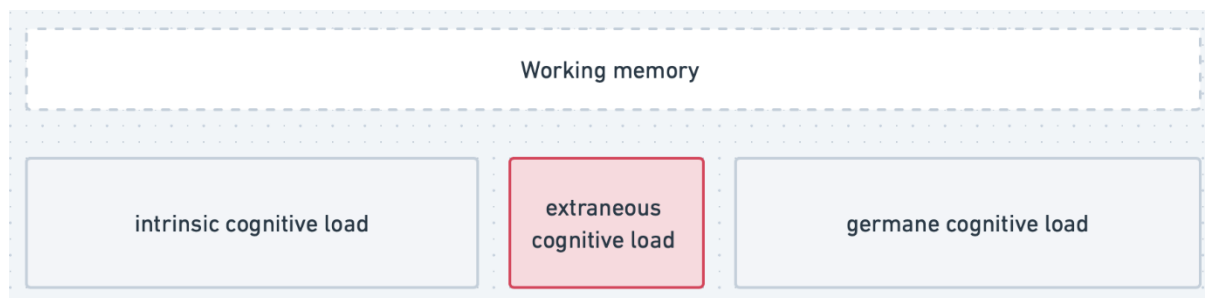*Note: Own illustration based on [10]*

According to CLT, it can be assumed that the free capacity of working memory depends on how many resources the other cognitive loads claim. In the exemplary case of the e-Learning program e-VELP, the extraneous load of the participants takes up a significant portion of the participants cognitive load. It thus has significant effects on the other two cognitive load. It is desirable to minimize the extraneous cognitive load, which is caused by the non-personalized and non-optimal design of the learning materials and thus influences the actual learning process an outcome. The design factors that may have led to such extraneous cognitive load may be long texts, too few examples, lack of multimedia learning that presents information combinations of text and pictures, and inappropriate navigation aids during the program. The intrinsic cognitive load, i.e., the intellectual demand of the contents, seems to be in an appropriate range. Also, the germane load, i.e., the handling of available resources in the working memory, is not criticized. Thus, the program seems structured so that the learning process for the target group of migrants and refugees represents a reasonable load.

Demands for optimizing e-Learning

Based on the evaluation of the study and the theoretical knowledge, there is a need to reduce extraneous cognitive load through the redesign of the e-Learning course to allow better allocation of the cognitive load dedicated to the learning process. The most crucial redesign

suggestions to reduce the extraneous load, as mentioned above, could be a multimedia presentation of the content to alleviate the intrinsic load, especially from the challenges of the language barrier of migrants and refugees who learn the content in a foreign language. Accordingly, the working memory could be relieved with the help of it, as can be seen in Figure 5:

Figure 5 - Demands for structural improvements of e-Learning programs based on CLT and CTML
Note: Own illustration based on [10]

Compared to Figure 4 a learning situation is visualized, showing a learning process appropriate for the framework conditions and adapted to the target group's needs. The extraneous cognitive load has been reduced so that more capacity is left for the other two cognitive loads, and the entire free potential is exploited without overtaxing. With the help of this approach, learning should remain motivating, despite complex e-learning topics, by no longer leading to overload due to defective materials and linguistic simplifications, especially for learners in cohort 3. Learning with a few different forms of presentation was noted as a deficit in the study and should be optimized based on the CTML.

Limitations and further research

Limitations arose during the survey implementation due to a low response rate caused by a lack of willingness to participate, resulting in a minimal sample size of 15 participants. Only 36% of all individuals participated in the survey, thus limiting the representativeness of the results for the target audience. The surveyed individuals were also selected participants in live training and had to meet specific prerequisites. Consequently, the study is not representative as the respondents were systematically chosen beforehand and likely have a different cognitive language proficiency threshold than other migrants and refugees from various contexts and language proficiency levels. In this regard, further research is needed to determine the extent to which the previously established expectations hold with a more significant number of participants. The obtained results raise the question of whether the expectations could potentially be confirmed if there is a more substantial number of respondents with a lower cognitive language proficiency threshold and whether, as a result, the language complexity of the e-Learning program should be reduced to reach a broader target audience. In the survey, 26% of the respondents indicated that they learned English as their native language, allowing for a good comparison for further research.

Additionally, it can be noted that during the implementation, it became apparent that the chosen method had limitations as the participants showed limited willingness, especially in providing detailed answers to the open-ended questions. For future research, conducting interviews or focus groups with the surveyed individuals could be considered to potentially obtain more detailed responses and better understand the reasons behind the answers.

This study applied a combination of content-structuring analysis and descriptive statistics; future studies can also consider adopting advanced quantitative analyses over time to investigate, for instance the course of motivation. It might be interesting to include and observe the effects of intrinsic motivation on cognitive load.

Conclusion

The findings in the paper highlight the multifaceted considerations involved in optimizing e-learning programs while considering cognitive load. In essence, it becomes evident that comprehending the target audience serves as an initial and invaluable compass for enhancing digital learning initiatives. The study demonstrates a divergence in cognitive load between the different participants and their perceived project success, e.g., non-native speakers perceived the project to be more challenging than native speakers as the former had trouble understanding the content, thereby increasing cognitive load.

Addressing the research question, "How do language skills influence the efficacy of an e-learning program for migrants and refugees?" yields insights into language's impact on both program success and motivation. In cases where the cognitive load is concerned, practical recommendations encompass the following:

- Streamlining complex language usage.
- Simplifying intricate subject matter.
- Incorporating diverse presentation modalities.

To sum up, an effective strategy would encompass deploying modules featuring concise text, visual cues like pictograms or instructional videos, and integrating visual aids such as tables and diagrams to distill content. This departs from the traditionally used linguistic-symbolic model that heavily relies on extensive text blocks and frequent external references within the existing learning content.

With reference to the presented EU project RAISE, we can report that there is a current undergoing reevaluation, which involves integrating individualized background knowledge, learning approaches, and language proficiency to construct a data-driven decision model. The ultimate objective is to create a program that mitigates the external cognitive load on each learner.

Data availability

The dataset generated for this study is available on request to the corresponding author.

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ПЕДАГОГИКАЛЫҚ ТҰРҒЫДАН САНДЫҚ ОҚЫТУДАҒЫ КОГНИТИВТІК ЖҮКТЕМЕНІҢ ЖЕКЕ ТЕОРИЯЛАРЫН КӨРСЕТУ – МИГРАНТТАР МЕН БОСҚЫНДАРҒА АРНАЛҒАН ЭЛЕКТРОНДЫ ОҚЫТУ БАҒДАРЛАМАСЫНДАҒЫ ТІЛ ДАҒДЫЛАРЫНЫҢ ӘСЕРІН ЭМПИРИКАЛЫҚ ЗЕРТТЕУ

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Түйін. Когнитивтік жүктеме теориясы (CLT) және когнитивтік мультимедиялық оқыту теориясы (CTML) адамның жұмыс жадысы элементтердің шектеулі санын ғана сақтай және сақтай алады деген тезисті қарастырады.

Когнитивті шамадан тыс жүктемені тудырмай, оқу процесінде жеке қабілеттерді пайдалану. Осы теориялық тұжырымдарға сүйене отырып, дәстүрлі цифрлық емес оқыту әдістері әдетте тиімдірек деп саналады, себебі сандық мультимедиялық дизайнға байланысты когнитивтік жүктеме азырақ болуы мүмкін;

Дегенмен, заманауи технологияларды қолдану арқылы электрондық оқыту бағдарламалары сияқты цифрлық білім беру ұсыныстары өзгертілсе және студенттердің қажеттіліктеріне бейімделсе тиімді болуы мүмкін.

Бұл мақалада тілдік кедергілер CLT және педагогикалық тұрғыдан мигранттар мен босқындарға арналған электрондық оқыту бағдарламаларының сәттілігіне қалай кері әсер ететінін зерттейді.

CLT және CTML теориялық негізі ЕО қаржыландыратын «Жас босқындарға арналған AI студенттерінің мүмкіндіктерін кеңейту бағдарламасы – RAISE» жобасы аясында жиналған эмпирикалық деректерден алынған нәтижелерді түсіндіру үшін қолданылады. Жобаның мақсаты – оқытудың оңтайлы қарқынына және студенттің қажеттіліктеріне бейімделетін педагогикалық стратегияларды қалыптастыру арқылы қатысушылардың тәжірибесі мен танымдық дағдыларын беру. Зерттеу когнитивтік жүктеме теорияларына негізделген мигранттар мен босқындарға арналған электронды оқыту бағдарламаларының құрылымдық талаптарын зерттейді. Негізгі идея электрондық оқыту күрделі және айтарлықтай жұмыс жады ресурстарын қажет етеді. Бұл әсер сыртқы талаптар сәйкес когнитивті жұмыс жады ресурстарынан айтарлықтай асып кеткен кезде оқуды нашарлататын деңгейге дейін айтарлықтай артады.

ОТРАЖЕНИЕ ИНДИВИДУАЛЬНЫХ ТЕОРИЙ КОГНИТИВНОЙ НАГРУЗКИ В ЦИФРОВОМ ОБУЧЕНИИ С ПЕДАГОГИЧЕСКОЙ ТОЧКИ ЗРЕНИЯ – ЭМПИРИЧЕСКОЕ ИССЛЕДОВАНИЕ ВЛИЯНИЯ ЯЗЫКОВЫХ НАВЫКОВ В ПРОГРАММЕ ЭЛЕКТРОННОГО ОБУЧЕНИЯ ДЛЯ МИГРАНТОВ И БЕЖЕНЦЕВ

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Резюме. Теория когнитивной нагрузки (CLT) и когнитивная теория мультимедийного обучения (CTML) рассматривают тезис о том, что рабочая память человека может хранить и сохранять только ограниченное количество элементов, и решают, как использовать индивидуальные способности в процессе обучения, не провоцируя когнитивную перегрузку. Основываясь на этих теоретических открытиях, традиционные способы нецифрового обучения обычно считаются более эффективными, поскольку благодаря цифровому мультимедийному дизайну может возникнуть меньшая когнитивная перегрузка; однако с использованием современных технологий цифровые образовательные предложения, такие как программы электронного обучения, могут быть эффективными, если их модифицировать и адаптировать к потребностям учащихся. В этой статье исследуется, как языковые барьеры могут негативно повлиять на успех программ электронного обучения для мигрантов и беженцев с точки зрения CLT и педагогической точки зрения.

Теоретическая основа CLT и CTML применяется для интерпретации выводов на основе эмпирических данных, собранных в рамках финансируемого ЕС проекта «Программа расширения прав и возможностей студентов AI для молодых беженцев – RAISE». Целью проекта является передача опыта и познавательных навыков участников путем формирования педагогических стратегий, которые адаптируются к оптимальному темпу обучения и потребностям учащегося. В исследовании изучаются структурные требования программ электронного обучения для мигрантов и беженцев, основанные на теориях когнитивной нагрузки. Основная идея заключается в том, что электронное обучение является сложным и требует значительных ресурсов рабочей памяти. Этот эффект значительно возрастает до такой степени, что он вредит обучению, когда внешние требования значительно превышают соответствующие ресурсы когнитивной рабочей памяти.

Ключевые слова: теория когнитивной нагрузки (clt), когнитивная теория мультимедийного обучения (ctml), электронное обучение, языковые навыки, мигранты и беженцы.

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