



Development and Integration of a Digital Reflection Assistant as a Complement to Building Physics Education

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Abstract

Tailored to the students of architecture and interior architecture at the OWL University of Applied Sciences and Arts in Detmold, the project focuses on developing and integrating a digital reflection assistant called "As U know" to complement building physics education.

The reflection assistant is introduced in an application-oriented module and brings together a diverse range of learning resources including sample exercises, glossaries, videos, tests, quizzes and more. Special focus is placed on interactive videos that are intended to support the development of problem-specific solutions for the complex requirements arising from the students' own designs.

Many architecture and interior architecture students struggle with the challenge of harmonizing the learned principles of building physics with their individual creative design processes. As a result, face-to-face correction discussions offered are often used ineffectively or even avoided by students due to insecurity. To counteract this, "As U know" provides students individual support independent of time and location, helping them prepare effectively for correction discussions.

In a survey conducted as part of the project, all users stated that the test version had supported or had rather supported them in applying the required building physics content. Forty six percent reported feeling less or tendentially less inhibited in taking advantage of the face-to-face corrections.

Keywords: *digital reflection assistant; blended learning; individual support; interactive video*

1. Introduction

Due to growing environmental concerns, increased demands for building thermal performance, rising energy prices, and the rising incidence of building defects, building physics has become an immensely important discipline in architectural planning. Consequently, future professionals are expected not only to address individual aspects but, more crucially, to navigate purposefully within the comprehensive context of interdisciplinary workflows.

Tailored to students in the fields of architecture and interior architecture at the Ostwestfalen-Lippe University of Applied Sciences and Arts, this project centers on developing and integrating a digital reflection assistant named "As U know" to complement building physics education. Following the acquisition of essential fundamentals in the "Building Physics and Technical Outfitting of Buildings" module, architecture and interior architecture students encounter the reflection assistant in the application-oriented, interdisciplinary "Construction Project" module.

Distinguished by its predominantly design-oriented focus, the "Building Physics and Technical Services" module differs significantly from other courses at the Ostwestfalen-Lippe University of Applied Sciences and Arts. It encompasses both physical fundamentals and lectures that integrate these fundamentals into practical applications, while also imparting methods to provide engineering-standard evidence. When tackling building physics and building services planning tasks in the "Construction Project" module, students are presented with various construction or building services implementation options. However, these tasks require students to demonstrate problem-solving skills and insight, if not a deep understanding, in the early stages of solution development.

Based on experience, many architecture and interior architecture students struggle with integrating the principles of building physics into their individual and creative design processes. This often leads to ineffective face-to-face correction discussions in the module or avoidance by students due to insecurity and shame, exacerbating existing disparities in performance and knowledge levels among students. To address this challenge, "As U know" provides students with the opportunity to engage with a time- and location-independent reflection partner, aiding them in applying technical fundamentals to their individual problems.



2. Structure and design of the digital reflection assistant “As U know”

The reflection assistant is embedded in the university's learning platform, Ilias, and brings together a diverse range of learning resources into so-called Knowledge Knots, including sample tasks, lectures, glossaries, elaborated topic pages, links to laws and DIN standards, tests, quizzes, instructional videos, and interactive videos. Some Knowledge Knots delve into additional subtopics, forming interconnected relationships with one another. Within the reflection assistant, thematic connections are linked, facilitating a comprehensive understanding of the content across different areas.

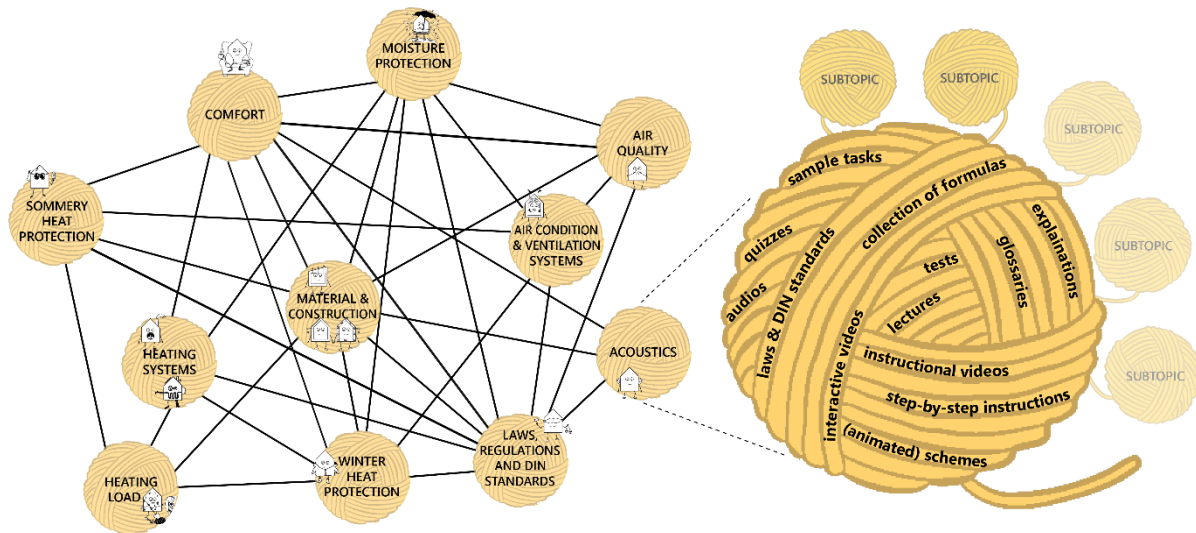


Fig. 1: Schematic representation of the contents of topic-specific "Knowledge Knots" and thematic references and dependencies among the different "Knowledge Knots"

A special focus is placed on interactive videos, designed to support the development of problem-specific solutions for complex requirements arising from their own designs. These videos directly address users, providing topic-specific information, important tips, examples, and targeted links to respective Knowledge Knots. To make individually relevant information easily accessible, branching scenarios have been employed, allowing users to choose from multiple options, thereby deciding what they see next. Thus, users play an active role in determining the course of the videos. Additionally, the interactive videos incorporate cleverly embedded quiz questions to encourage users to actively participate and develop solutions independently. Therefore, the interactive videos provide thought-provoking insights and accompany students in the decision-making and problem-solving process.

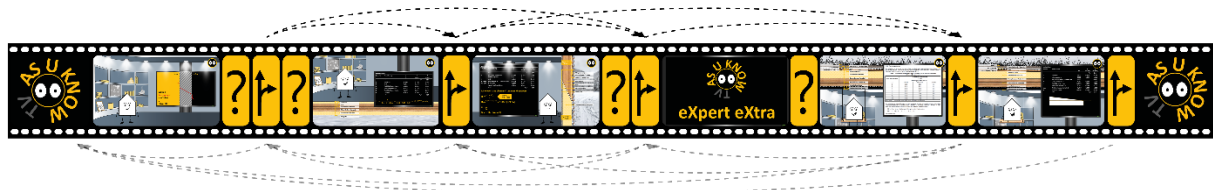


Fig. 2 Schematic representation of "Branching Scenarios," quiz questions, various studio extensions, and the "eXpert eXtra" format within an interactive video (Show: Thermal transmittance: Calculation of the heat transfer coefficient of various types of building components)

Through the problem-based approach, students gain a deeper understanding of the learning content [1]. Furthermore, this approach fosters thinking strategies, critical thinking [2] and the development of problem-solving-skills: the ability to transfer reasoning strategies to new problems [3]. Students also retain the learning material for longer durations [4].

Interactions within the learning process stimulate interest in the subject matter, motivating students to engage in learning, elevating their curiosity, and maintaining their interest [5]. Additionally, the incorporation of interactive videos has been shown to significantly improve learning outcomes and increase learner satisfaction [6]. With the integration of gamification elements, these videos provide an



enjoyable and playful learning experience, effectively sustaining viewers' attention and encouraging them to invest more time in the content.

The videos are animated and specially designed for the project. They are set in an imaginary television studio, hosted by an animated character developed for the project. Various thematic references are placed in the background.

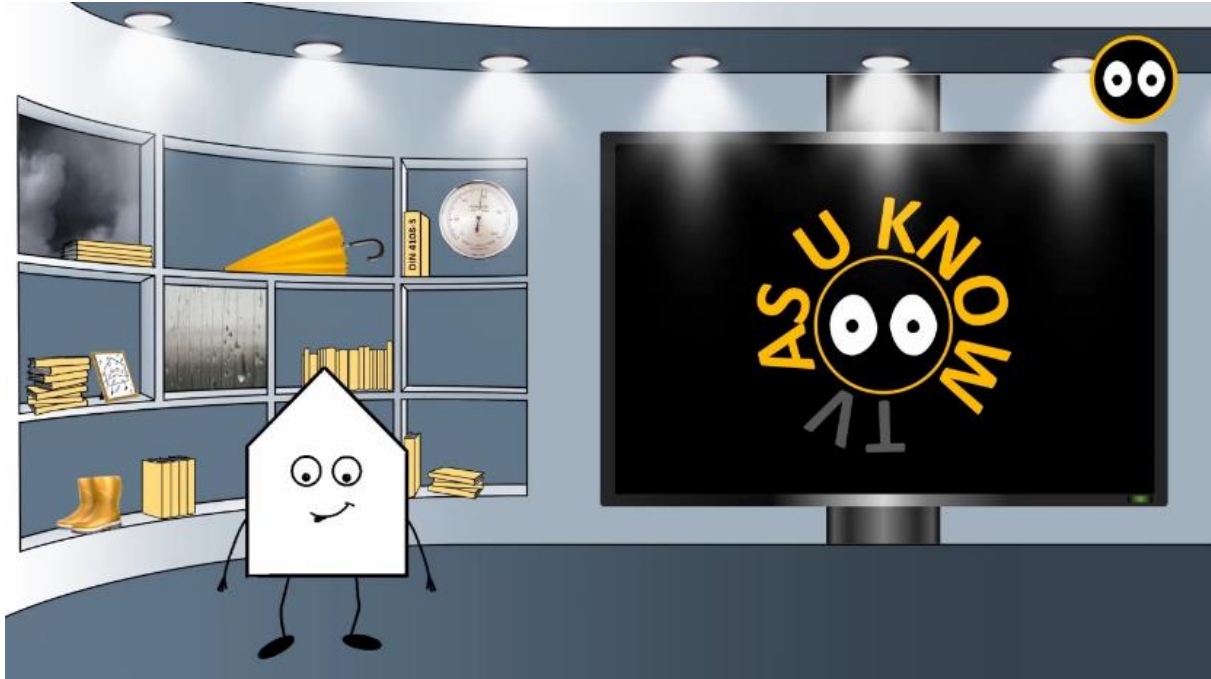


Fig. 3 "TV As U know" Host in the "TV As U know" Television studio with a host equipped with thematic references in the background (Show: Moisture Protection: Demonstration of Glaser method according to DIN 4108-3)

Selected storytelling elements are consistently maintained to ensure a cohesive and meaningful learning experience [7]. The videos create the atmosphere of a live broadcast, highlighting the timeliness and relevance of the conveyed information. Information, calculation methods, or important hints are displayed on the television screen in the background. It also serves as a platform for special guests who provide additional explanations and expert knowledge. These special guests are integrated into the videos using skillfully edited lecture video material from various professors at the Ostwestfalen-Lippe University of Applied Sciences and Arts. Depending on the content, the videos have different studio extensions.

"As U Know" is mentioned as an assistant because its diverse functions and wide range of learning resources help students to learn in a highly personalized manner through their own self-organized chosen supports and at their own pace [8]. To facilitate navigation among Knowledge Knots, various thematic units feature a consistent page layout, with similar types of learning resources placed consistently and formatted uniformly. A standardized layout template for additional topic pages was created, providing placeholders for all possible content types. A continuous use of terminology for the best possible orientation was also implemented.

For instance, in the Knowledge Knots related to verification methods, the focus is on application, providing step-by-step instructions, important hints on special rules or common errors, formula collections, and sample tasks. In Knowledge Knots related to technical building services, example calculations are rarely required, but instead, the presentation of technical devices, their functioning, and integration into holistic systems are necessary. This was implemented primarily through animated images, which are particularly suitable for illustrating movement sequences and changes in states.

Each Knowledge Knot has its own icon, representing the moderator of the interactive videos. However, this icon is equipped with corresponding items, accessories, and clothing, depending on the thematic area. The iconographic representation helps users quickly orient themselves and identify or recognize relevant content.

In addition to the ongoing process support learning resources, a gallery of outstanding projects from past academic years has been initiated to offer support to students. Here, students from previous



academic years present their results in short personal videos, discussing the development of their design idea, project context, any difficulties encountered during planning, and their respective solution strategies. The explanation of individual approaches, problems, and solutions is of great importance as it occurs on a level playing field among students. The best practice videos are intended to further motivate students, guided by the assistant, to systematically reconsider and develop their actual architectural design ideas, which sometimes entail complex issues. They aim to assist students in assessing the quality of their own work within the context of student projects.

3. Insights from Student Surveys on the Test Version of "As U know"

After the halfway point of the project timeline had passed, two surveys were conducted among participants of the "Construction Project" module. The group of participants in the "Construction Project" module consisted of students from the fields of architecture and interior architecture. The surveys were implemented relatively early in the project timeline to ensure a significant period of time for responding to the wishes, concerns, and initial feedback of the students during the second half of the project. To gather initial user feedback, a test version of As U know was made available to the test group. Excluding the interactive videos and the best practice videos, the test version already included a large part of the intended content for all Knowledge Knots.

3.1 Survey on the Need of "As U Know"

The first survey aimed to assess students' support needs, subjective difficulties in applying building physics concepts to their individual designs, reasons for these difficulties, and preferred learning resources. This survey was crucial in understanding the support needs, refining the content focus of the interactive videos, and identifying potential gaps or weaknesses in the compiled materials.

Nearly 77% of the participants reported that applying the learned building physics concepts to their individual designs was somewhat difficult or even very difficult for them, with 11% indicating it was very difficult or even absolutely overwhelming. Among these respondents, 50% attributed this to a lack of review materials, 44% to insufficient time, 22% to other reasons, and 39% stated they could not assess which content was relevant to their individual design.

To harmonize theoretical content from the 'Building Physics' module to my creative design is... ..for me.

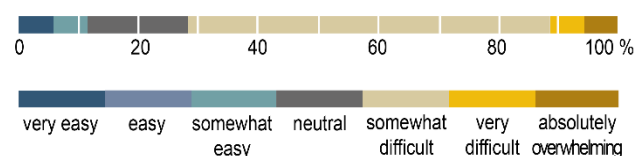


Fig. 4: Extract from the first student survey on the need of "As U Know"

Furthermore, students were asked to assess their knowledge in various subject areas, represented by the "Knowledge Knots," themselves. It is particularly noticeable that some topic areas were considered particularly complex by a large number of students. For example, nearly 33% of students indicated that their knowledge of heating load was poor or rather poor. In the field of acoustic systems, it's even 48% who stated having a poor or rather poor level of knowledge.

3.2 Survey on the Impact of the Test Version of "As U Know" and User Feedback

To obtain a direct assessment from users during the semester, a test version was released three weeks before the exams in the "Construction Project" module. This test version included a significant portion of the planned learning resources, excluding the interactive videos. After a testing period of three weeks, a second survey was conducted. This survey primarily focused on determining the number of users among the participants and gathering user feedback on the design, structure, and individual use of "As U know," as well as the personal benefit gained from "As U know."

Approximately 35% of the participants in the "Construction Project" module reported using "As U know." This was confirmed by the online participant list in the "As U know" course on Ilias.

All users reported that it was easier, or rather easier, for them to integrate the required knowledge into their individual designs with the help of the assistant. One hundred percent of users stated that they appreciated receiving time- and location-independent support through "As U know".

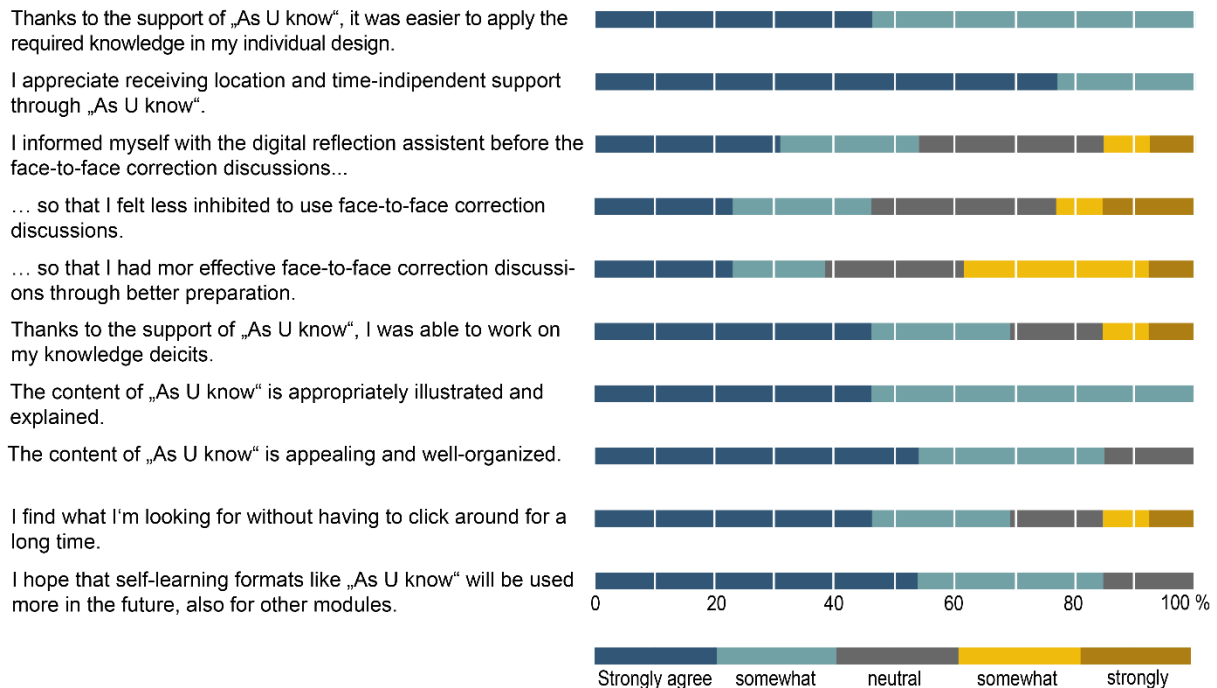


Fig. 5: Extract from the second student survey on the impact of "As U Know": User Feedback

Furthermore, 46% stated that they were less, or rather less, inhibited about participating in face-to-face conversations, and 38.5% indicated that they had more effective, or rather more effective, feedback discussions as a result of preparation with "As U know".

All users find the contents of the assistant appropriately, or rather appropriately, illustrated and explained, and almost 85% of the users indicated at least the tendency that the contents are attractively and clearly presented. The survey also revealed that 77% of the users wish for the addition of further interactive videos to the reflection assistant. Additionally, nearly 85% of the respondents wish for more self-learning formats like "As U know" to be used for other modules in the future.

3.3 Discussion of the Results from the Student Surveys

The first survey confirms the impression that many students encounter difficulties when applying the required knowledge to their individual design projects. Furthermore, it is evident that many students express a need for more well-structured review materials to be made available to them. Additionally, there appears to be a lack of clarity among students regarding the transfer of content.

The relatively low utilization rate of the test version, with only 35% of respondents having engaged with it, can be attributed to several factors. Firstly, the limited uptake during this phase can be explained by the specific circumstances surrounding the project timeline and the academic semester schedule. Students had only a brief three-week window, immediately preceding their exams, to explore the test version of "As U know." Typically, at this stage in the semester, many students have already advanced significantly in their design planning and are primarily focused on the practical execution of their projects, including the creation of design representations. Furthermore, it's worth noting that some students who did not utilize the test version mentioned in their free-text comments that they were unaware of its availability, despite prior announcements. These students expressed a desire to use it had they known about it. Therefore, there is a potential for increased adoption through more strategic timing of its release and improved communication and promotion strategies.

It's important to emphasize that the reflection assistant is designed as a supplementary tool to complement the existing teaching framework, and it's not expected that all students within the module will utilize it. Hence, achieving a usage rate of over a third of the students, with the possibility of further growth through refined timing and promotional efforts, is indeed a positive outcome.

Regarding the timing aspect, it's worth mentioning that the issues observed with the test version's availability do not apply to the final version of "As U know." This final version is scheduled for completion and will be accessible at the start of the upcoming summer semester, eliminating any



timing-related concerns. While the test version of "As U know" was promoted in various ways within the "Construction Project" module, the feedback from some students indicated that they were still unaware of its existence. To address this, potential solutions include ramping up advertising efforts and implementing reminders. Additionally, availability throughout the semester and subsequent word-of-mouth promotion will likely mitigate this.

3.4 Survey Analysis and Interim Conclusion

The feedback from all users of the test version indicating that they felt generally supported by the reflection assistant is fantastic validation for the project. The reported increase in confidence during face-to-face discussions and the desire for more interactive content suggest that the project is addressing relevant student needs.

We could specifically identify three areas for further development in our project: firstly, more interactive and audience-specific content; secondly, increasing the reach of As U know through the use of more or more effective advertising; and thirdly, extending the availability beyond the time boundaries of the "Construction Project" module. Overall, the survey results emphasize the relevance and success of the project, motivating us to further advance the project.

4. Advancements in the Project following Survey Analysis

Thanks to the early feedback collection, we were able to give significant importance to user input in the further development of the tool. This made it possible to better address the desires and needs of the students in four areas: Availability, Content, Usability, and Promotion.

4.1 Availability

Initially, it was planned that "As U know" would be made available to students during the duration of the "Construction Project" module. When the semester was over, we decided to keep the test version available online and thus move the 'As U know' course out of the 'Construction Project' course, where it was previously located, to an upper level in the course hierarchy of the OWL University of Applied Sciences and Arts. The move also allows us to offer the assistant internally for additional modules and other study programs within the university, thereby expanding the reach of the tool. Meanwhile, it is being used in four modules: "Building Physics and Technical Services," "Construction Project," "Building Construction 3," and the elective course "Building Energy Consultancy" within the department.

4.2 Advancements in Content and Usability

To improve the usability of "As U know," additional information on how to operate the platform has been added to the homepage alongside the selection menu. The interface of "As U know" has been enhanced with a navigation bar and an increased density of direct links. Additionally, a greater quantity of learning resources has been developed for the "Knowledge Knots," which are perceived as particularly challenging. Furthermore, as planned, several interactive videos have been created.

4.3 Measures to promote "As U know"

In the upcoming issue of the university's internal magazine "52Grad," an article about "As U know" will be featured, accompanied by a QR code that directly leads to the "As U know" course. On the homepage of the department of building physics and technical equipment, there is now an animated link as well as a brief promotional and explanatory text about the digital reflection assistant. While in the modules "Building Physics and Technical Services", "Construction Project", "Building Construction 3", and the elective course "Building Energy Consultancy", "As U know" appears as an animated disturber on the respective course homepages. Of course, the instructors also point out the possibility of using the tool.

5. Conclusion and Outlook



The main project goal of supporting students in integrating Building Physics and Technical Services content into their own designs has been generally achieved according to feedback from the surveyed users. Additionally, we were able to continue gathering user feedback through the expanded accessibility. For this purpose, we have introduced an anonymous forum in the course, which, has been used only sparingly by the students so far. Furthermore, we were able to extensively address both content-related and structural desires and needs of the students, thus improving student support. Extending the reflection assistant for use in other modules is technically feasible and could be considered in future projects.

In the remaining project timeline, the focus will be on completing contents for the reflection assistant, especially on further developing interactive videos, as this was also a desire expressed by many students. Alongside the addition of interactive videos and a few final adjustments to the content and functionality of applications, we aim to publish the "As U know" Ilias course under Creative Commons license to ensure flexible use of the material and to enable others to benefit from the project. By doing so, we seek to facilitate easy adaptation of the course to diverse educational contexts, fostering collaboration and knowledge sharing within the education community. Overall, we want to maximize the impact of the "As U know" project and contribute to the broader advancement of education.

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