Conceptual Design of an AI-Based Learning Assistant

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Abstract

Within interdisciplinary work processes, students are increasingly expected to develop transfer competences for complex, overarching content. We suggest the research-led development of a Digital Reflection Assistant. This AI-based tool is designed to foster students in developing and applying such competences. Based on the own evaluations and preliminary studies on the learning and working behaviour of our students, the tool is intended to promote a comprehensive understanding in interdisciplinary contexts as well as the development of integral solution processes in application-oriented project modules. The digital assistant serves as an individual, time- and location-independent reflection partner in the transfer process of the technical basics to specific, project-related problems.

Keywords: Artificial Intelligence, intelligent tutoring system, reflection, project-based learning, online-learning, interactive video

1. Introduction

Interdisciplinary competences have become a crucial part of university education during the last two decades. Besides, the use of Artificial Intelligence becomes more and more relevant to the broad field of higher education [1, 2]. In this paper, we will sketch a conceptual design which will enable university teachers to bridge interdisciplinary skill building with cutting-edge AI technology. Our goal is to develop in a research-based manner a reflection partner implemented in application-oriented project modules. We build upon recent discourse on Knowledge Management in university education (see [3] with further literature). On the one hand, the digital assistant is a technology that can be used independently of a disciplinary context, and on the other hand, very specific technical content turns out to be particularly suitable for its digital scaffolding support functions.

Our field of application will hence be the building sector education at the post-secondary level. Challenges in this sector especially derive from the interdisciplinary content in combination with a high level of technical differentiation: Within the building sector, a multitude of engineering disciplines work together on technically sophisticated projects. For a successful project execution, it is necessary that each project participant has an overview of the wide range of activities within the project and understands the influence of his own services on other fields in order to act accordingly with foresight.

Architects in particular often have a coordinating role in projects and must understand the intersections of disciplines as well as their crucial planning aspects. Therefore, architecture students learn design aspects as well as legal, physical and constructional fundamentals. This is usually done in a project-related manner in order to convey the necessary methodological skills.

This diverse content with regard to the individuality of the respective student projects as well as strengths and weaknesses of individual students requires intensive face to face supervision by the professors and their staff and requires frequent repetition of already taught basics, to support the students in transferring theoretical information to project-related application. OWL University is an ideal location within Germany for this specialist context: almost half of all German interior design students' study at the Detmold School, all of whom pass the examination in building physics/building services engineering.

The project will be considered successful if its students are guided within an ILIAS-based reference system with diverse forms of media mediation (*knowledge nodes*).

Those nodes are integrated in short interactive videos with dynamic content as a "springboard" to specific points within a complex knowledge tree structure, which serve as a trigger for reflection and to activate transfer knowledge.

2. Research-led Educational Development

In order to develop an educational concept for incorporating digital tools in teaching building physics for architecture students, a survey of 55 students was conducted during the winter term 2018/2019 [4]. The module *Building Physics and Technical Construction* is a module with a large proportion of technical and theoretical content that requires a high degree of transfer competences.

The main subject of the survey was the self-assessment of learning behaviour, learning methods as well as underlying documents and needs for digital tools. In addition, the survey also determined the degree of difficulty of individual topics.

In conclusion, the students mainly prepare themselves for exams by repeating arithmetic exercises as well as test exams and summarize lecture notes. In addition, 80% of the students search for additional information on the Internet. The desire for digital tools goes mainly in the direction of a digital wiki with technical expressions, videos on applying examples, regular anonymous test questions as well as videos with commented solutions in regard to mathematical issues. Yet, lecture recordings, a public forum, internal instant messaging or videos on fundamental knowledge from school are not considered relevant by the group surveyed.

Additional teaching experiences, especially in connection with the module "building physics", show that students are overstrained with time management due to the large number of project deliveries within the paralle-running modules. This results in individual priorities of the students in a way that many students do not participate in the supervisions at the beginning of the semester and demand especially last-minute supervision and rather need a time-independent opportunity to reflect their solutions.

Furthermore, it is apparent that the students need a lot of support in the transfer process to apply theoretical knowledge to their individual project task.

3. Conceptual Design of a Digital Reflection Assistant

To overcome the challenges described above, we have started to develop a video-based assistant which interactively combines a variety of learning and information formats and which serves the students as a personal, time- and location-independent reflection partner for the development of methodological competence. This enables abstract and theoretical contents to be exemplified by individual problems. Therefore, the assistant is a link between abstract, theoretical content to its project-specific application.

The key feature of the AI tool is an interactive video-supported linking of heterogeneous information sources and learning formats.

It is realized as a complex interaction tool using AI technology. It is based on an open source plugin “interactive video” for a learning management system (ILIAS). The interaction tool accompanies the module’s teaching components by supplementing various educational support functions (scaffolds) and by offering both different learning paths and options for in-depth study of the learning contents [5]. The options for in-depth study are implemented as integrated online applications (e.g., recordings of lectures, glossaries, quizzes, arithmetic exercises, videos etc.). (Fig. 1)). We speak of an assistant, because the various functions help the students to learn in a highly personalized way, using their own, self-organized, self-chosen help functions and at their own pace [6] and because we will organize these functions according to specific user stories and combine them into a supporting character in the sense of a uniform teacher [7]. By this we mean a fictional person who represents a supervising teacher and who responds to the individual needs of the learners (e.g., by explaining specific technical terms, illustrating mathematical contexts with the help of topic-specific application examples or providing further interactive materials for self-study, but also by formulating important questions and providing food for thought). Thus, we programmatically follow the concept of user-oriented software design [8].

For this purpose, the digital assistant will refer to so-called knowledge nodes which are embedded in a learning management system. Knowledge nodes are particular learning formats as well as information sources (lecture material, standards/rules, data sheets, etc.). The AI assistant should encourage and systematically guide students to rethink and further develop their actual ideas. It allows for anonymous, independent reflection on one’s own planning, which reduces the obstacles to taking advantage of personal face-to-face correction during the presence phase. At the same time, the digital assistant can consolidate and deepen skills and thus provide case-based impressions of interrelationships and interactions. It therefore facilitates individual, interactive and video-supported links between heterogeneous information sources and exercises and stimulates reflective thinking within the transfer process of technical fundamentals on project specific tasks.

The educational setting begins with the planning/design process as shown in the center of the assistant. Students start with their problem definitions (e.g., material selection, construction, type of technical equipment and so on). Interactive videos guide them considering their individual topics (e.g., thermal insulation, energy regulations, air quality) and continue with further questions (e.g., condensation, energy demand, air exchange). The videos provide relevant information, important hints and links to the knowledge nodes. The Reflection Assistant thus provides impulses and accompanies the students in the decision-making and development process to find their own solutions.

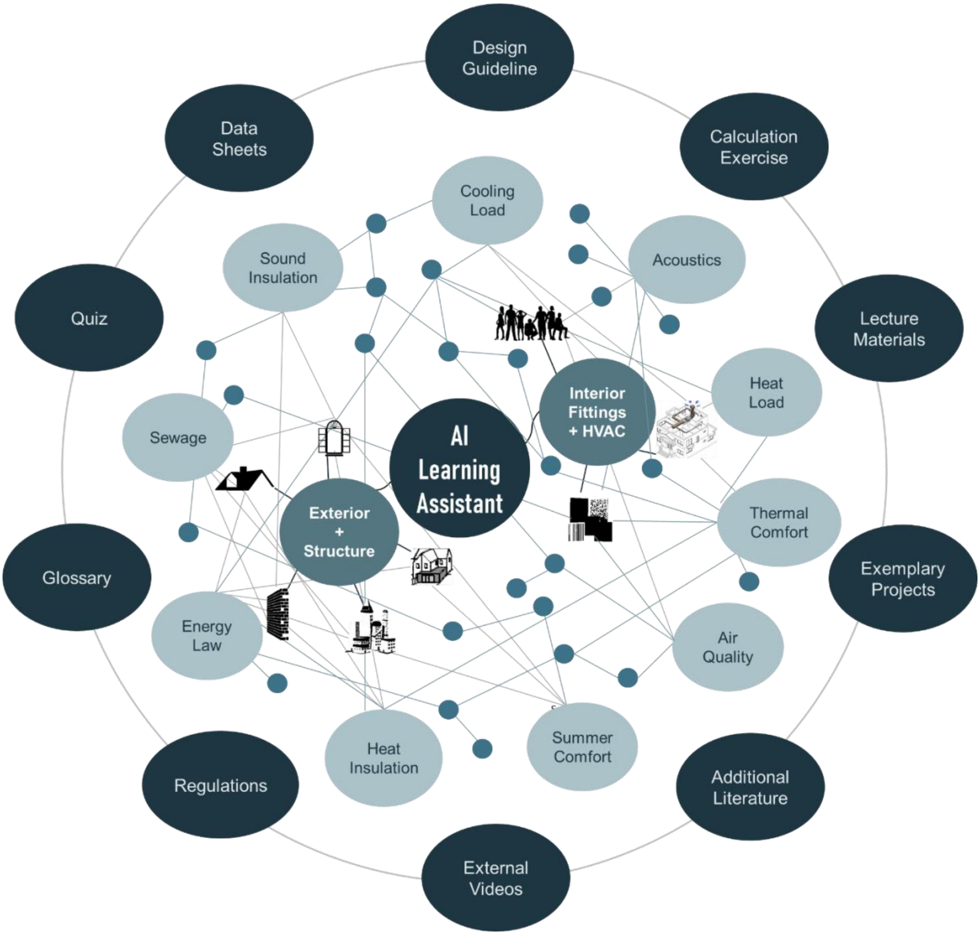

Fig. 1. Reflection Assistant – a conceptual overview

4. Summary

With the project presented here, we are pursuing the goal of developing a university teaching concept for the online-based mediation of demanding technical contents. Thus, the project pursues the task of reducing the technical complexity in an appropriate way, as well as the task of preparing this content on the basis of a media-educational overall concept and staging it within a Learning Management System in such a way that it can be used to promote academic learning.

The designed reflection assistant can be extended as desired to include several fields within building industry, such as structural engineering, urban and spatial planning, settlement and water management, and its implementation can also be transferred to many other interdisciplinary study fields.

All of our technological developments will be made openly available via GitHub (https://github.com/) and they can thus potentially be used by other institutions to integrate video-based digital assistants. Likewise, we will make the research-based external learning materials freely available together with our content as Open Educational Resources (OER), so that they can be used or further supplemented by third-party contributions.

REFERENCES

[1] Schmohl, T., Watanabe, A. & Fröhlich, N. (2020). How Artificial Intelligence can improve the Academic Writing of Students. *The Future of Education*, *10*.

[2] Schmohl, T., Löffl, J. & Falkemeier, G. (2019). Künstliche Intelligenz in der Hochschullehre. In T. Schmohl & D. Schäffer (Hrsg.), *Lehrexperimente der Hochschulbildung. Didaktische Innovationen aus den Fächern* (Teaching Xchange, Bd. 2, S. 117-122). Bielefeld: wbv media.

[3] Schmohl, T. (2020). Multimodale Wissensorganisation. Ein Modell zur schreibdidaktischen Begleitung von Promotionen. In A. Aebi, S. Göldi & M. Weder (Hrsg.), *Schrift-Bild-Ton. Einblicke in Theorie und Praxis des multimodalen Schreibens* (S. 85-106). Bern: hep.

[4] Slabon, M. (2019). *Digitale Didaktik in der Bauphysik. Erstellung eines didaktischen Konzeptes zur Integration einer digitalen Lernbegleitung im Fach Bauphysik für Architekten*. Bachelor Thesis. Supervised by S. Schwickert & T. Schmohl. OWL Technical University of Applied Sciences and Arts, Detmold.

[5] Hmelo-Silver, C. E., Duncan, R. G. & Chinn, C. A. (2007). Scaffolding and Achievement in Problem-Based and Inquiry Learning. A Response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist*, 42 (2), pp. 99-107.

[6] Schmohl, T. (2019b). Selbstgesteuertes Lernen. Explorative didaktische Formate mit Modellcharakter für vier akademische Statusgruppen. In T. Schmohl, D. Schäffer, K.-A. To & B. Eller-Studzinsky (Hrsg.), *Selbstorganisiertes Lernen an Hochschulen. Strategien, Formate und Methoden* (TeachingXchange, Bd. 3, S. 19-40). Bielefeld: wbv media.

[7] Holt, E.-M., Winter, D. & Thomaschewski, J., (2011). Personas als Werkzeug in modernen Softwareprojekten. In: Brau, H., Lehmann, A., Petrovic, K. & Schroeder, M. C. (Hrsg.), Tagungsband UP11. Stuttgart: German UPA e.V. (S. 40-44).

[8] Arnold, P., Gaiser, B. & Panke, S., (2005). Personas im Designprozess einer E-Teaching Community. In: Haake, J. M., Lucke, U. & Tavangarian, D. (Hrsg.), DeLFI 2005: 3. Deutsche E-Learning Fachtagung Informatik, 13-16. September 2005 in Rostock, Germany. Bonn: Gesellschaft für Informatik e.V. (S. 469-480).