

Integration of EPLAN into Project-Based and Self-Directed Learning for Automation Students

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Abstract – In technical education, numerous methods of knowledge transfer exist—from traditional lectures and guided exercises to problem- and project-based approaches. However, when learning complex CAE software such as EPLAN, it becomes evident that students benefit significantly more from action-oriented learning formats that combine guidance and autonomy. Initial feedback and observations show that project-based learning is clearly superior to traditional methods, as it promotes active engagement, immediate application of knowledge, and independent problem-solving through self-directed learning (SDL). This paper describes the integration of EPLAN into a project-based learning environment for automation engineering students, complemented by Virtual Instructor-Led Training (VILT) sessions and the provision of dedicated e-learning modules that support and scaffold the learning process. These e-learning modules provide structured theoretical content, interactive exercises, and supplementary explanations, enabling students to prepare effectively and progress at their own pace within a self-directed learning framework. The study further analyzes the students' learning outcomes while developing small automation-related systems. Through a combination of short theoretical units, VILT-supported introductory tasks, digital learning materials, and an independently executed project, learners were able to create complete electrical schematics, device lists, and structured documentation. The results show a clear improvement in technical competence, understanding of electrical standards, and the ability to comprehend industrial workflows. The study thus demonstrates that the project-based, VILT-enhanced, and e-learning-supported instruction of CAE skills is not only more sustainable but also more practice-oriented, effectively preparing students for professional requirements in the field of automation technology.

Keywords - Project-Based Learning (PBL), VILT, E-learning, CAE Software (EPLAN), Automation Engineering Education

I. INTRODUCTION

In an increasingly digitalized world, self-directed learning (SDL) is becoming more significant. It's an “educational method in which learners plan, implement, and assess their learning, align with those of 21st-century education.” [1] It enables learners to shape their educational journey independently, whether through informal learning in everyday life or structured programs on digital platforms. Additionally, SDL is an essential component of blended learning concepts, which combine traditional face-to-face sessions with online learning modules. Self-directed learning assumes that learners can independently grasp the learning content. This means that with this form of learning,

learners can independently design and direct their own learning process. Self-directed learning can be used in any setting and for any group of learners, from kindergarten children to experienced employees.

According to [2, 9] self-directed learning is a combination of motivation, knowledge and ability. The learner must be ready and able to take on the planning, execution and evaluation of their learning independently and on their own responsibility. In order for students to be able to organize their learning autonomously, they need a range of skills that cannot be taken for granted from the very beginning. Students must not only be able to independently set goals and take the necessary learning steps, but also have a repertory of study skills (such as managing effort, scheduling and knowledge) and be able to self-evaluate their own learning progress.

Here are some examples of self-directed learning .

MOOCs

Massive open online courses are an excellent example of self-directed learning. The instructors design the content of the course, and learners can then complete it at their own pace and according to their own learning style.

These types of courses are widely used in universities and businesses. Sometimes they supplement traditional learning methods, but they can also be used as a standalone learning method.

Library of learning

Just like a regular library, a library of learning is a place where students can go to read about their chosen subject. Unlike a regular library, however, a library of learning is a database that students access online.

Here they can independently search for resources, learn about topics and techniques, and answer their questions. This type of self-directed learning resource is easy to create with the help of a good learning management system (LMS) or learning experience platform (LXP) [10,11].

Microlearning

Microlearning is a type of self-directed learning that takes place in short units. The lessons cover one topic and can be completed in a few minutes.

Microlearning is often associated with the gamification of learning, which combines competition, rewards, and levels to motivate and engage learners.

Regardless of the form of microlearning, these short, bite-sized lessons are a convenient way for employees or learners to learn new skills or improve existing ones.

Open-ended research projects

Independent research projects are a great form of self-directed learning for school-age learners. Teachers set a broad assignment and then act as facilitators, supporting and encouraging students as needed.

Students are given free rein with how they interpret the assignment, and they spend time digging into a topic that interests them before presenting their research project to the class. There are many pros and cons of the SDL.

II. BENEFITS OF PROJECT-BASED AND SELF-DIRECTED LEARNING IN CAE EDUCATION

Project-based learning offers numerous advantages that are valuable for both learners and organizations when learning how to work with CAE tools like EPLAN [3,14]

Hands-On Application of CAE Tools

Project-Based Learning enables students to apply CAE software such as EPLAN in realistic engineering scenarios. This direct use of professional tools strengthens practical competence and confidence.

Improved Understanding of Electrical Standards and Workflows

By working on complete engineering projects, learners gain a deeper understanding of electrical standards, documentation requirements, and typical industrial workflows used in automation engineering.

Enhanced Problem-Solving Skills

CAE projects require students to analyze system requirements, resolve design conflicts, and make technical decisions independently, fostering structured and solution-oriented thinking.

Higher Motivation Through Visible Learning Outcomes

The completion of a finalized electrical project—such as full schematics and documentation—allows learners to clearly recognize their learning success, which significantly increases motivation.

Support of Self-Directed Learning (SDL)

Project-Based Learning encourages students to explore software functions, documentation, and best practices independently, promoting self-directed learning skills essential for professional engineering practice.

Better Preparation for Industry Requirements

The close alignment of project tasks with real-world automation projects prepares students effectively for professional roles in electrical design and automation engineering.

Self-directed learning offers numerous advantages that are valuable for both learners and organizations [3].

Flexibility and Individualized Learning

Learners can arrange their learning times and locations flexibly, adapting the pace to their individual needs. This allows for better integration of learning into personal daily routines and accommodates different life circumstances.

Independence

By taking responsibility for their own learning process, learners develop important skills such as self-organization, initiative, and decision-making. These competencies are crucial not only for educational success but also for professional life.

Motivation

The ability to set personal learning goals and pursue individual interests can increase intrinsic motivation. Learners are often more engaged and more willing to interact with learning materials when they have chosen them themselves.

Improved Job Performance

SDL promotes the application of knowledge in real-world contexts, potentially leading to improved job performance. Employees can acquire specific skills directly relevant to their professional tasks, increasing their efficiency and effectiveness.

Cost Savings

Organizations can reduce training costs through SDL since fewer in-person training sessions are required, and learners can independently access resources. Additionally, employees can learn at their own pace, minimizing downtime.

III. CHALLENGES OF SELF-DIRECTED LEARNING

Despite its many benefits, especially self-directed learning also presents challenges that must be addressed [4].

Uncertainty About What to Learn

Without clear guidance, learners may struggle to determine which content is relevant and in what order they should study it. This can lead to knowledge gaps or an overemphasis on less important topics. (online-lernen-mit-learndash.de)

Lack of Time

Integrating learning activities into a busy schedule requires effective time management. Many learners struggle to prioritize learning phases over other commitments, which can hinder progress.

Lack of Intrinsic Motivation and Interest

Not all learners have the necessary intrinsic motivation to

successfully engage in SDL. Without external incentives or pressure, it can be difficult to stay consistent and pursue learning goals.

Overwhelm Due to Too Many Choices

The abundance of available learning materials and methods can be overwhelming. Learners may have difficulty selecting the right resources, leading to decision paralysis or inefficient learning.

Focus on Immediate Needs

Learners tend to focus on topics they currently find interesting or necessary. This can lead to neglecting important foundational knowledge or long-term relevant content essential for future challenges.

IV. FOSTERING MOTIVATION IN SELF-DIRECTED LEARNING ENVIRONMENTS

One key motivation is that learners can clearly perceive their learning success at the end of the learning project. For example, this may take the form of a completed and finalized project that integrates and demonstrates everything they have learned on the subject so far. Self-directed learning can be described as a process in which learners are ready and able to individually plan, manage, realize, monitor, and evaluate their learning, either in cooperation with other learners or independently, taking full responsibility for their own learning progress. Accordingly, self-directed learning requires both certain abilities and a readiness (motivation) on the part of learners. While the development of abilities for self-directed learning generally raises fewer problems in practice (for example through targeted training-related learning strategy training), the identification and promotion of motivational conditions proves to be much more difficult. It has been shown that despite the best digital learning offerings, such as eLearning, learners find it difficult to work effectively with them. Some students have shown that individuals who have learned without instructors have shown poorer learning outcomes than those who have had the support of a mentor, even though they were provided with more and better-prepared learning material. According to these studies and recommendations, to overcome these challenges and foster motivation in self-directed learning, several strategies can be applied [5,7,8].

Clear Goal Setting

Establishing specific, measurable, and achievable learning goals can help learners track their progress and stay motivated. Clear goals provide direction and a sense of purpose.

Providing Resources

Access to high-quality learning materials, tools, and platforms facilitates the learning process. Support from mentors or coaches can also be helpful in answering

questions and providing feedback.

Encouraging Self-Reflection

Learners should be encouraged to regularly reflect on their learning progress, celebrate achievements, and learn from failures. This strengthens awareness of their own learning process and promotes self-efficacy [12].

Creating a Supportive Learning Environment

An environment that values and promotes learning can enhance motivation. This includes both physical spaces and a culture that supports continuous learning and development.

Integrating Reward Systems

Incentives such as certificates, recognition, or career benefits can provide extrinsic motivation and encourage learners to achieve their learning goals.

The question is, is this enough? In practice, it has been shown that without a targeted introduction and explanation of the learning idea, which can be found in eLearning, neither the student nor the lecturer knows how to best start with the learning material and what the learning didactic approach is that the creator of digital learning materials has come up with when preparing learning materials. It has been shown that not even the best teaser videos or descriptions and guides can replace what an expert can explain to the learner group. Some creative companies have tried out new solutions that have led to SDL learning materials being consumed much better and more efficiently and also used for learning purposes. In the following, we present a case study of the company Eplan GmbH & Co.KG.

V. CASE STUDY: STUDENTS WORKSHOP

EPLAN GmbH & Co. KG [6] has developed self-directed learning content for students, educators, and lecturers. To ensure effective implementation and increase learning motivation, the company organized an "International Education Workshop" in an online format.

The first workshop was designed for a group of students from various countries, including Poland, Croatia, Bosnia and Herzegovina, Serbia, and the Netherlands. The goal was to recreate a project from the eLearning program in a hands-on seminar. This served not only as an introduction to the content but also as a targeted measure to reduce the initial challenges of self-directed learning. The interactive participation and direct exchange with experts and peers created a supportive environment that provided clarity on learning objectives and strengthened participants' intrinsic motivation.

After the online workshop, participants received access to eLearning materials to independently review the content. This structured approach helped minimize the feeling of being overwhelmed by too many choices and encouraged focused learning. Additionally, many participants reported that the combination of a live workshop and self-directed

learning helped them use their time more efficiently and feel more confident in selecting relevant learning content.

Students who submitted the completed project to EPLAN received a certificate, serving as an extrinsic motivational factor. The first workshop registered 54 participants, followed by another workshop for Italian students with 191 registrations [13].



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Eplan Education – Workshop dedicato esclusivamente alle scuole italiane!
Nelle giornate del 3 e 4 dicembre i professori e gli studenti italiani hanno avuto l'opportunità di lavorare direttamente con i colleghi di Eplan Germania su un progetto elettrico reale, guidati dall'esperienza del team dedicato a Education.

Al workshop hanno partecipato più di 200 professori e ragazzi provenienti da tutta Italia!

Alcuni studenti erano alla prima esperienza in un laboratorio didattico, altri invece avevano conoscenze più avanzate ma si sono dimostrati tutti curiosi e dinamici al fianco dei loro docenti.

Questo workshop non solo ha permesso loro di imparare a utilizzare il software Eplan Electric P8, ma ha rappresentato per questi ragazzi una grande opportunità di crescita personale e professionale poiché si è svolto interamente in lingua inglese e ha dato loro la possibilità di relazionarsi con esperti del mondo del lavoro.

Complimenti a tutti i professori che si sono distinti e hanno riconosciuto in questo workshop offerto da Eplan Education una grande opportunità per i propri alunni!

Eplan Italia è orgogliosa delle sue scuole, e di contare su studenti tanto promettenti.

Un caloroso ringraziamento ai colleghi tedeschi a **Dr. Dusko Lukac, Grecia Alzamora** e Robin Bleich.



Figure 1. EPLAN Education Workshop in Italy

The most significant success was achieved with 707 registrations for Spanish students.



Figure 2. Italian students working with EPLAN eLearning

VI. INFORMATION ON THE FEEDBACK EVALUATION OF THE CERTIFICATION PROJECT

As part of our certification program, participants were given the task of working on a project based on the content delivered through the training and the accompanying eLearning. The objective was to accurately replicate and further develop the presented project within a timeframe of six weeks.

Participants were required to submit their project by a clearly defined deadline and in a specified format. Once submitted, each project was carefully reviewed by a qualified jury. The jury evaluated the quality of the work as well as adherence to the formal requirements. Based on this assessment, a decision was made as to whether a certificate would be awarded. In cases where only minor errors were identified, participants were informed of the issues and granted a revision period to make the necessary corrections.

A total of **94 projects were submitted**, of which **89 were awarded a certificate**. This result reflects a high level of commitment and a solid understanding of the course content.

Feedback from both participants and instructors was overwhelmingly positive. Many expressed their satisfaction with the structure, the level of challenge, and the overall learning experience. A selection of their comments has been summarized in the following table.

What did you like most about the event?
el conocimiento de los profesores
Disponer del video de la videoconferencia para seguirlo a mi ritmo
Resolución de problemas.
Conocimientos y profesionalidad del profesor
Que ha iniciado desde lo más básico, lo cual vienen bien para recordar.
La tranquilidad y saber hacer del docente Dusko.
Aprender el uso y las funcionalidades del software
La sección de macros, diseño general de circuitos de cualquier tipo y los reportes finales del proyecto
La parte puramente técnica que hemos aprendido sobre cómo manejar eplan.
Aprender algunas de las cosas que no conocía en Eplan
La preparación de los profesores
Dusko knew what he was explaining
La presentación sobre el propio programa. Disponer del video para revisarlo. Tener acceso a la formación
Otras formas de trabajar con Eplan, trucos y atajos
The step by step instructions.
La claridad y facilidad a la hora de explicar el programa.
Practico completamente
La explicación de la corrección de errores es lo que más útil me ha resultado.
EL PODER APRENDER COSAS NUEVAS
the practice program and information
fast overview of main tools
Haber descubierto algunas funcionalidades que desconocía
It was easy to understand duskos explanation
El trabajo paso a paso.

As part of the feedback process, They were also invited for improvement suggestions. Most participants stated that they had no specific suggestions. However, a few pointed out that due to the large number of participants, there were occasional delays in response times and feedback delivery.

Do you have any suggestions for us to improve future events?
me ha parecido todo correcto
Ahora mismo no.
Enviar antes del curso más documentación que haga más fácil seguir el curso.
Es mucha información en tiempo reducido. Podría ampliarse a una jornada más
Se podrían realizar más niveles y ya para pedir con menos gente. Nos solemos perder bastante y a veces resulta demasiado
Asegurarse de que la gente haya descargado e instalado el software de forma correcta, ya que más de la mitad del tiempo h
Quizas añadir mas secciones de contenido a los eLearnings
Falta mejor organización de la reunión. Idealmente se deberían desactivar los micrófonos de la gente incluso el chat. Los así
Me parece que se ha pasado demasiado el curso para repetir las mismas cosas, más aun sabiendo qque se iba a mandar en
La parte del manejo de teams para evitar que alumnos tomen el control, silenciar a alumnos, etc. Agradecería algún tipo de
1. I was waiting for a file with the requirements of the project we have to submit. 2. Sometimes the session goes too slow b
Disponer de la formación online durante más tiempo. O que quedara permanente para los profesores.Incluir otros aspectos
Las dudas deberían ir todas al final. Demasiadas interrupciones.
A second part for this workshop with increased difficulty degree.
Si, es entendible que haya gente con dudas, pero a veces se hacía un poco pesado que Dusko contestara dudas sobre cómo l
Podría ser todo en castellano, pero se pudo entender.Se agradece MUCHO que en ocasiones aclarase en castellano, gracias.
Hacer un segundo taller un poco más avanzado
NO
.
no
Realizarla es castellano daría mucha más agilidad
It was great
Por ahora ninguna.
Si la realización de más wokshop sobre bornes, propanel, etc.
Intentar que aunque la clase sea en ingles, las grabaciones se puedan ver en español tambien

The dedication, active involvement, and constructive feedback of all participants significantly contribute to the ongoing enhancement of the program’s quality.

This high level of participation and positive feedback highlights that a well-structured introductory workshop can significantly enhance learning motivation and serve as a crucial support mechanism for self-directed learning. It is a measure of how eLearning can become more attractive and how the barriers to use can be reduced.

VII. CONCLUSION

Self-directed and project-based learning offers numerous benefits, yet it also comes with challenges that can be mitigated through targeted measures. The combination of an introductory workshop followed by access to eLearning content has proven to be an effective strategy for increasing learners' motivation and providing clear guidance. The interactive introduction facilitates the learning process, reduces uncertainties, and enables participants to deepen their knowledge at their own pace. The experiences from the International EPLAN Education workshop demonstrate that such a structured approach not only increases acceptance of self-directed learning but also leads to better learning outcomes.

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