Artificial Intelligence in the Classroom: Supporting Teachers in Addressing Electrical Engineering Preconceptions

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Abstract

This research paper examines the suitability of AI tools for teaching the fundamentals of electrical engineering. The research question addressed in this paper focuses on the quality of AI-suggestions to counteract the preconceptions (misconceptions) in courses for first-year students. To address this question, a generative AI tool is examined regarding the identification of preconceptions and measures within learning processes. Subsequently, the author undertakes a systematic evaluation of all suggestions. The results show that the AI tool identifies numerous potential preconceptions (up to 80), although some of them refer to the same underlying preconception. For instance, the preconceptions "energy and current are the same thing" and "more current automatically means more energy consumption" are equivalent. Furthermore, in the second instance, the AI "unconsciously" introduces a preconception that focuses on energy consumption rather than conversion. Unfortunately, the AI makes such statements in the suggested materials for learners. This can engender further preconceptions. In planning learning-teaching arrangements, AI tools have shown effectiveness in engaging learners by counteracting preconceptions through experimentation and simulations. In summary, despite their limitations, the results of the AI tool can be considered adequate. The amount of generated information may be overwhelming for inexperienced teachers, who may encounter difficulties in identifying the key preconceptions. Consequently, the deliberate integration of AI tools into training programs for (future) teachers is imperative, a point also addressed in this paper.

Keywords: preconceptions, first-year curriculum, electrical engineering, experiential learning

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Introduction

Electrical engineering is widely regarded as an abstract discipline because many of its underlying phenomena cannot be perceived directly by the human senses. For instance, while electrical current can be perceived through its (often dangerous) effects on the human body, it is not possible to directly observe the flow of electrons or the magnetic field generated in the process. This fact makes it particularly challenging for learners at the beginning of their educational programs to grasp the fundamentals of electrical engineering. The issue is further compounded by the abstract nature of the subject matter, which frequently necessitates mathematical modelling of related concepts. This is often challenging for learners to understand, thereby creating an additional hurdle in the learning process.

One approach to conceptualizing abstract content involves the establishment of explanatory patterns, which are often termed "preconceptions." These preconceptions frequently offer valid descriptions of specific situations, providing a helpful framework for learners. However, learners often overgeneralize these explanations and apply them to situations in which they are no longer appropriate.

Future teachers need to understand the concept of preconceptions so that they can, on the one hand, identify unhelpful preconceptions among learners and, on the other hand, create learning opportunities to reduce these unhelpful preconceptions and/or replace them with helpful ones. In this context, the support provided by generative AI tools can be an important option for expanding instruction to address this issue. In accordance with this premise, the present paper will address the following research question: To what extent can generative AI support future teachers in designing lessons on the fundamentals of electrical engineering that explicitly address students' preconceptions?

To answer this research question, ChatGPT is used as an illustrative example whose responses are analyzed from a subject-specific didactic perspective. The background section serves two purposes. First, it serves to contextualize the author's research activities within the domain of subject-specific didactics. Second, it provides a rationale for the selected research topic. Subsequently, the AI tool's results are presented and discussed from a subject-specific didactic perspective. Finally, the paper concludes with a summary and an outlook.

Theoretical Framework

This section introduces constructivist didactics, preconceptions, and the conceptual change framework.

Constructivist Didactics of Electrical Engineering (cDoEE)

Constructivist didactics of electrical engineering (cDoEE) is a subject-specific educational framework that focuses on the fundamentals of electrical engineering (Jambor, 2022). This is because this particular field poses a significant challenge for novices and experienced teachers alike, resulting in a considerable need for support in this field.

Theories of cognition and learning associated with constructivism, as well as approaches of transactional analysis (Stewart & Joines, 1987), serve as the theoretical framework for these considerations on subject-specific didactics. A brief overview of constructivism is provided by, for example, JAMBOR (2024). For the purposes of this paper, it is sufficient to note that the constructivist approach posits an active construction of one's own knowledge structures and considers direct knowledge transfer between teachers and learners to be impossible. Consequently, the traditional roles of the teacher as the primary knowledge provider are being redefined. The new paradigm places the teacher in a more facilitative and supportive position. Concurrently, the responsibility for one's own learning processes shifts to the learners, since they are the only ones who have control over these processes. Conversely, the role of the teacher shifts towards fostering motivation in learners and cultivating an environment conducive to learning. A positive perspective on human beings is adopted from the perspective of transactional analysis. In its first thesis, entitled "People are okay," the manifesto underscores the principle of human dignity and repudiates the establishment of a hierarchical structure among individuals. Instead, individuals are assigned roles (e.g., teacher, student) in different situations, which may involve a hierarchy in specific areas (e.g., performance assessment). The second thesis, entitled "Everyone has the capacity to think," allocates responsibility for one's own decisions and their consequences to all individuals. Consequently, teachers are neither obligated nor justified in making decisions on behalf of learners. The third thesis focuses on decision-orientation, positing that individuals have the capacity to revise and permanently alter their decisions (Jambor, 2024; Stewart & Joines, 1987).

In accordance with this framework, the following objectives are pursued within the cDoEE (Jambor, 2022):

- O1. In the context of the fundaments of electrical engineering, which is frequently characterized by its abstract nature, the *motivation of learners* is a critical success factor in the design of learning and teaching processes. It is imperative to nurture this motivation to ensure the efficacy of these processes.
- O2. Teachers should identify *preconceptions* regarding the fundamentals of electrical engineering as either helpful or unhelpful. Helpful preconceptions should be strengthened, whereas unhelpful ones should be reduced or replaced.
- O3. The *significance of subject-specific knowledge*, particularly in the domain of the fundamentals of electrical engineering, should be underscored. This knowledge functions as a crucial fundament for more advanced content.
- O4. Concurrently, the accumulation of *inert knowledge* should be avoided, ensuring the maintenance of a focus on competency-based instruction. The term "inert knowledge" refers to knowledge that has been acquired by the individual but cannot be spontaneously applied to problem-solving. Access to this knowledge is only possible after a stimulus from the outside world (Renkl et al., 1996).

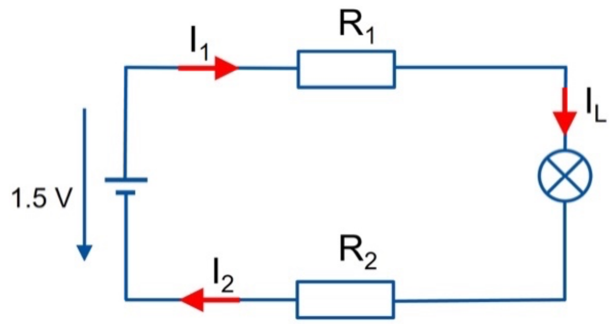
The primary focus of this paper is on objective O2, although it is imperative to acknowledge the continuous integration of learner motivation (O1) and the reduction of inert knowledge (O4) as inextricable components of effective teaching and learning arrangements. The targeted and meaningful use of appropriate tasks also contributes to O3.

Preconceptions

Preconceptions play an important role not only in the domain of electrical engineering, but also in other fields of education. The development of preconceptions occurs not only within the context of formal learning environments but also in a variety of other informal settings (Adimayuda et al., 2026; El Fathi et al., 2025; Munawwarah & Ashari, 2025). The origins of individual preconceptions are multifaceted, including everyday language (e.g., "Electricity consumption is rising"), language utilized in educational settings (e.g., incorrect use of verbs such as “Electrical voltage flows.”), perceptual patterns derived from visual representations (e.g., field lines that represent a field and imply field-free space between them), and experiential factors (e.g., connecting a device with a cable and the invisibility of the three wires inside the cable) (Schecker & Duit, 2018). Moreover, analogies (e.g., the water flow model) also foster additional preconceptions.

A frequently observed preconception is illustrated by the circuit depicted in Figure 1. When asked to predict the effect of increasing the resistance R_1, the majority of learners correctly identified a decrease in the current I_L and in the brightness of the lamp. When the resistance R_2 is increased, some learners hypothesize that the brightness of the lamp will remain constant. They justify this phenomenon by asserting that the resistor is situated “behind” the lamp, thereby rendering it ineffective. This preconception is reinforced by the fact that, in most circuits, the resistor intended to limit the current and influence the brightness of the lamp or LED is indeed located “before” the lamp. Additionally, in the German language, the resistor is referred to as a “Vorwiderstand” (pre-resistor), and the required position is implied by the name.

Figure 1
Circuit for Illustrating a Preconception



The author of this paper is unaware of any uniform classification of preconceptions, and thus only a few examples of individual approaches can be cited here. In German-speaking countries, the following classification approaches are commonly utilized, among others:

1. URBAN-WOLDRON and HOPF (2012):
    a. Electric current as a substance that resides in a battery and then flows through the circuit
    b. Concept of current consumption
    c. Concepts related to electrical resistance (e.g., “An increase in the internal resistance of a voltage source leads to an increase in the electric current flowing through the circuit”)
    d. Localized thinking (e.g., “At every junction, the current decides anew how to split”)
    e. Sequential argumentation (e.g., “The magnitude of the current before and behind a component is influenced only by that component”)
    f. Problems with topological structure (e.g., “A parallel connection is only recognized if it is explicitly shown as parallel.”)
2. WILHELM and HOPF (2018):
    a. Concepts from early science learning (e.g., “A single wire from the battery to the consumer is sufficient”)
    b. Concepts related to voltage (e.g., “Voltage is a property of electric current, so a voltage drop occurs even without a resistor”)

   c. Concepts regarding electricity as a fuel (e.g., “Electricity is consumed”)
   d. Basic thinking patterns (e.g., “local thinking”)
3. SCHORN, ABLAß and VOIGHT (2023):
   a. open and closed circuits
   b. series and parallel circuits
   c. electric current
   d. electrical resistance
   e. electrical voltage

The aforementioned approaches are all centered on the rudimentary electrical circuit and lack a more sophisticated grasp of the fundamentals of electrical engineering. This can be attributed primarily to the fact that the underlying studies were conducted in general education schools as part of the physics curriculum, as well as during the introductory phase of university programs.

In addition to comprehending preconceptions, identifying them poses a significant challenge for teachers. This aspect will be further demonstrated using the example illustrated in Figure 1. It is conceivable that, when the resistance R_2 is increased, learners will infer a reduction in the current and the brightness of the lamp. However, it is important to note that this conclusion may be based on a false preconception. If learners assume that, in the physical direction of current flow, resistor R_2 is located before the lamp, the teacher may fail to recognize the incorrect conclusion. Therefore, learners must consider both cases.

Conceptual Change

Learners initially perceive their preconceptions as helpful, which leads them to retain them without the motivation to modify or supplant them with alternative preconceptions. POSNER et al.’s Conceptual Change Theory provides a useful framework for addressing unhelpful preconceptions. The authors identify four conditions necessary for the elimination of unhelpful preconceptions and the development of helpful ones (Posner et al., 1982):

1. Learners must experience dissatisfaction with their existing preconception in order to regard it as unhelpful.
2. The new concept, to be incorporated into cognitive structures as a helpful preconception, must have been understood (at least in part).
3. The new concept must be comprehensible, at least in part, and thus plausible to the learners.
4. The new concept must be transferable to new problems.

To satisfy the first condition, it is necessary to deliberately create cognitive conflicts among the learners. The author of this paper begins by requesting that the learners articulate their hypotheses concerning a particular phenomenon. Subsequently, the learners engage in a discourse with their peers to discuss these hypotheses. Consequently, experiments are conducted with the specific objective of refuting their existing preconceptions.

In the example illustrated in Figure 1, learners are instructed to formulate a hypothesis regarding the functionality of resistor R_2 and subsequently construct the associated circuit. The observations and measurements derived from the circuit demonstrate that learners' preconceptions are unhelpful. This fosters dissatisfaction with the existing preconception.

Results of the AI Query

In light of the widespread adoption of the AI tool ChatGPT, which was utilized by 48% of European students in 2025 (Lademann et al., 2026), GPT-5.5 serves as the illustrative case for this study. Given that the objective of this study is not to generalize the results but rather to conduct a subject-specific didactic evaluation of them, this provides an appropriate starting point for addressing the research question. The AI was prompted to assume the role of a novice vocational school teacher preparing to teach introductory electrical engineering. The author's own prior knowledge regarding preconceptions was presented as negligible.

The inquiry regarding the potential preconceptions in the domain of the fundamentals of electrical engineering has yielded a total of 80 suggestions. At the author's behest, each recommendation is articulated in a single sentence. Moreover, the preconceptions are grouped into twelve categories. The following list contains all categories along with two first exemplary preconceptions from each category. The number of preconceptions assigned to each category is indicated in brackets following the category name. The terms, which were originally provided in German, have been translated but not optimized or corrected for technical accuracy.

C1. Electricity (12)
- a. "Electricity is a substance that is consumed." (Electricity is thought of as a material substance that becomes "less" or disappears in electrical devices.)
- b. "Electricity is used up in the lamp." (The lamp is regarded as the endpoint of the current, beyond which nothing flows anymore.)

C2. Voltage (8)
- a. "Voltage is a current." (Voltage is misunderstood as something that flows.)
- b. "Voltage flows through wires." (Voltage is thought of in the same way as current.)

C3. Resistance (7):
- a. "Resistance completely stops the current." (Resistance is understood as a blockage, not as a limiting factor.)
- b. "Resistance weakens the current until it disappears." (The current is thought to decrease along the resistance.)

C4. Series (5) and parallel (5) circuits
- a. Series circuit: "The current is divided among the lamps." (An incorrect application of the parallel model to the series circuit.)
- b. Parallel circuit: "More lamps make each lamp dimmer." (Everyday logic: "more loads = less power")

C5. Electrical circuits (6)
- a. "Current flows only away from the positive terminal" (The closed circuit is not fully understood.)
- b. "One wire is enough" (The need for a return wire is unclear.)

C6. Switches (5)
- a. "Switch either lets current through or holds it back" (The switch is interpreted as a storage device.)
- b. "Switch consumes power" (It is perceived as an active load.)

C7. Measurements (8)
- a. "Measuring instruments always show correct values" (Measurement limitations and conditions are not considered.)
- b. "Voltage and current are measured the same way" (Different measurement methods are not known.)

C8. Circuit diagrams (5)
   a. “Circuit diagrams are to scale” (Geometry is overemphasized.)
   b. “The length of a wire in the diagram affects the current” (The graphical representation is interpreted in physical terms.)

C9. Energy and power (5)
   a. “Energy and current are the same thing” (Temporal aspects are missing.)
   b. “More current automatically means more energy consumption” (The role of time is ignored.)

C10. Power sources (5)
   a. “A battery is a current storage device” (Charge separation and chemical processes are unknown.)
   b. “A battery always delivers the same amount of current” (The influence of the circuit is ignored.)

C11. Safety (4)
   a. “Voltage is harmless; current is dangerous” (The danger posed by high voltage is underestimated.)
   b. “Low voltages are generally harmless” (Factors such as the environment and body resistance are not considered.)

C12. System level (5)
   a. “Components operate independently of one another” (Interactions are not recognized.)
   b. “Each component can be considered in isolation” (System thinking is lacking.)

In order to expand the systematization of preconceptions within the categories, seven conceptual models are provided. These can be regarded as a higher-level framework that groups individual preconceptions into overarching explanatory patterns. These are presented below, with a concise explanation by the author to accompany each. Furthermore, two preconceptions are invariably enumerated that the AI tool has assigned to the conceptual model. In instances where preconceptions have been previously mentioned, only a reference is provided here.

CM1. Substance model: Learners view electric current as something that behaves like a liquid (especially water) or a gas (especially air). This substance can be consumed, divided, and stored.
   a. see C1a and C1b

CM2. Linear transport model: Learners attempt to explain individual phenomena using the idea that electric current is transported from the source to the load. The circular nature of the process is neglected.
   a. see C1b
   b. “The first lamp (in a series circuit) has a stronger influence on the second.” (Linear cause-and-effect thinking dominates.)

CM3. Agent model: Learners attribute intentions, or a certain “intelligence”, to the components.
   a. “Current flows in only one direction because the lamp determines it.” (The load is seen as the controlling element of the current flow.)
   b. “One lamp draws current away from the other” (Loads are thought of as actively “taking” current.)

CM4. Local cause-and-effect model: Learners assume a component in a circuit has only a local effect and neglect its impact on the entire circuit.
   a. see CM3a

   b. "Changes only have a local effect" (Global effects in the circuit are underestimated.)

CM5. Mechanical force model: Learners replace invisible electrical quantities (e.g., current, voltage) with mechanical quantities (e.g., pressure, force).
   a. "Current is dangerous because it exerts pressure." (Danger is interpreted mechanically, not in terms of effects on the body.)
   b. "Voltage is the force of current" (Mechanical analogies dominate the conception.)

CM6. Measurement and representation model: Learners assume that measurements and representations are direct copies of reality. In doing so, they neglect measurement errors and limitations in modelling.
   a. see C7a and C8a

CM7. Additive-summative system model: Learners view circuits as a loose collection of components that do not interact with one another, and do not contribute collectively to the circuit's function.
   a. see C12a and C12b

Based on these conceptual models, the AI suggests a central hypothesis that all preconceptions can be traced back to a single cause. This is the learners' belief that electricity is a transportable substance.

The AI tool identifies four main challenges as factors in the identification of preconceptions. Firstly, linguistic overlay is defined as the use of correct terminology by learners without the corresponding conceptual understanding of the underlying meanings. This phenomenon leads to the masking of preconceptions by correct answers. A secondary issue pertains to academic adaptation, whereby learners are expected to commit to memory formulae, rules, and terms. This enables them to provide correct answers on knowledge-based tests that lack real-world application and to "conceal" their preconceptions. A similar issue is the context-dependence of preconceptions, which, on the one hand, enables the correct calculation of theoretical problems and, on the other hand, prevents the application of knowledge to everyday situations. Finally, the issue of indirectness is a challenge identified by the AI tool, which highlights that preconceptions are often not directly accessible and can only be discovered through the teacher's interpretation. The issue of identification, as mentioned in the discussion of preconceptions, can be assigned specifically to this category. It is important to acknowledge that this issue can result in preconceptions being overlooked or, through overinterpretation, being attributed to the learners.

In order to identify preconceptions, the AI tool provides a checklist upon request to assist teachers. For each preconception or group of preconceptions, a checklist containing 2–3 items is provided. The following examples illustrate the items for preconceptions C1a and C7a:

- C1a
    - Does the student mention "less electricity behind the lamp"?
    - Is electricity described as a limited resource?
    - Is the concept of a closed loop missing?
- C7a
    - Is critical thinking about measurements avoided?
    - Is no interpretation provided?

In terms of counteracting preconceptions, the AI Tool highlights that (unhelpful) preconceptions are relatively stable and must be destabilized and reorganized through the introduction of competing (helpful) preconceptions. Moreover, this context underscores the phenomenon that helpful and unhelpful preconceptions can coexist (e.g., one's own explanatory model vs. the memorized answer for the teacher). Based on this "understanding," a three-step approach is proposed. Firstly, the everyday model (unhelpful preconception) is activated. Secondly, conflict is deliberately generated through experiments. Thirdly, a new model (helpful preconception) is incorporated into the cognitive structures as a replacement. The AI tool integrates this approach into the conceptual change approach described above, even though the author did not explicitly mention it.

Interpretation of the Results

The complete interaction with the AI tool comprised approximately 130 A4 pages of output, with less than 1% of the content being produced by the author of this paper. Consequently, the volume of information that a prospective teacher must review during the evaluation process is substantial. Moreover, individual statements from the AI tool are reiterated, as they are rearranged and summarized upon request.

An examination of the 80 preconceptions reveals the presence of some duplications. Initially, genuine duplications can be identified, in which individual preconceptions are repeated almost identically. For instance, the preconception C1b is reiterated as the preconception "No more electricity flows past the last lamp." A similar duplication can be observed with the preconceptions C5b and "The circuit does not need to be closed." Such duplications can be identified eleven times, thereby reducing the original 80 preconceptions to 69. Additionally, individual repetitions can be traced back to shared causes, thus enabling their identification as duplicates. For instance, preconceptions C2a, C2b, and "Voltage is consumed" can be replaced by the preconception "Voltage as a flowing substance." A parallel consolidation can be identified in the context of viewing components as "independent" actors. Therefore, the preconceptions "Current flows in only one direction because the lamp determines it," "A lamp draws current away from the other," "The voltage source distributes voltage as needed," C6a, "The switch determines the brightness," and "The battery decides on the current" can be summarized as "Components make decisions and act purposefully." After removing genuine duplicates and consolidating conceptually equivalent statements, the original list of 80 preconceptions can be reduced to approximately 50 distinct preconceptions.

In addition to the repetition of preconceptions, a taxonomy can be established that distinguishes between *common*, *less common*, and rather *unconventional preconceptions*. This distinction is highly subjective and is based on the experience of the author of this paper, who has worked for a total of approximately 15 years in vocational and academic education as a teacher and lecturer. Additionally, the absence of mention of individual concepts in extant literature is employed as a significant indicator for classifying a preconception as one of the more unconventional types. From the author's perspective, *less common* preconceptions include the following: "Current stays at the negative terminal," "The lamp determines the direction of current," "One lamp draws current away from the other," and "Power is just a property of the device." Examples of more *unconventional preconceptions* include the following: "Electric current is dangerous because it pushes," C5b, "Current flows at different speeds," C3a, "Resistance exists only when current is flowing," and "The switch is a voltage source." It is imperative to acknowledge that the author's experiences are influenced by two primary factors: his learners and his approach in the classroom. For instance, the preconception C5b is more prevalent among younger learners who do not belong to the author's target group. The preconception "Current flows at different speeds" has never been encountered by the author, since the speed of charge carriers is never explicitly addressed by the author in his teaching arrangements. Consequently, it is possible for learners to hold this preconception and for the author to fail to identify it due to the author's focus.

In addition to the aforementioned limitations, it is important to note that not all of the preconceptions listed are genuine. An illustration of such a "pseudo-preconception" is the preconception "More lamps make each lamp dimmer," which is cited by the AI tool in the context of parallel connections. However, under the assumption of an ideal voltage source, this statement is found to be false. However, if a real voltage source (e.g., a standard battery) is used, learners can make this observation empirically. The statement of the "pseudo-preconception" is only to be considered a preconception when employed in the context of a (nearly) ideal voltage source. Linguistic nuances have the potential to serve as a contributing factor to the occurrence of misunderstandings. For instance, the preconception that "voltage can be measured on a single wire" is not inherently incorrect. The voltage drop can be measured on a wire; therefore, the statement does not represent an unhelpful preconception.

The systematization of the preconceptions using these categories is clear and combines the approaches presented in the fundamentals by Urban-Woldron and Hopf (2012) and by Schorn, Ablaß and Voight (2023). However, the AI tool supplements these preconceptions with categories focusing on measurements (C7), circuit diagrams (C8), and safety (C11), which are particularly relevant in the fields of vocational and academic education. The correlation between the categories and the conceptual models is clear. In this step, repetitions are removed due to the nature of the approach, thereby increasing the clarity of the list. From the author's perspective, the central thesis, that there is a single common cause for preconceptions, is an oversimplification. Moreover, it offers no direct didactic value, as it can only be used to justify avoiding explanatory models such as the water flow model. This approach effectively prevents the formation of new preconceptions; however, it does not address existing preconceptions that have been formed through various sources, such as the media (e.g., energy consumption) and learners' own observations outside of class (e.g., a cord (with two invisible conductors) for a floor lamp).

To identify preconceptions, the AI tool generates checklists that are particularly useful for novice teachers. This approach presupposes that learners will verbalize their assumptions. A thorough review of the checklists reveals that individual questions are derived directly from the preconception. However, the efficacy of these questions is not consistent. For instance, the preconception "Electric current can accumulate" is employed to formulate the question "Is a current bottleneck being described?" Additionally, the question "Is a static state rather than a process being conceived?" is included in the checklist for the aforementioned preconception. The first question is a natural extension of the preconceived notion and is therefore not explicitly necessary. However, the second question is somewhat misleading. In this context, the use of the term "process" to describe the flow is somewhat unconventional, although it is not necessarily inaccurate. The distinction between a static state and a process is a common element in checklists. This issue is further illustrated by the question "Is the temporal reference missing?" This question also implies describing the current as a static phenomenon. This indicates that distinct questions are devised for equivalent contexts, a situation that can prove particularly daunting for novice teachers.

The strategy for countering preconceptions has been identified in the domain of subject-specific didactics and is, consequently, applicable, as the approach is found on the

Conceptual Change Model. The only aspect that has not been explicitly addressed is the intentional verbalization of everyday notions. It is evident that experienced teachers can interpret the AI tool's output in a manner that validates the efficacy of the suggested approach. However, if the activation of learners' preconceptions during the experiments is only implicit, that is, if it is not verbalized, then the resulting conflicts between their preconceptions and the observed phenomena may be consciously or unconsciously ignored by the learners.

Conclusion and Outlook

In summary, the output of the AI tool is often comprehensive, which may overwhelm novice or prospective teachers. The repetitiveness and, in some cases, imprecise statements can generate uncertainty among the target group, which can have a counterproductive effect. This underscores the necessity of both subject-specific and didactic knowledge, as well as AI competencies, for two key reasons. Firstly, these competencies are essential for formulating precise prompts that elicit specific AI responses. Secondly, they are crucial for evaluating these responses with the requisite critical perspective. It is imperative that this be incorporated into the training of prospective teachers from the outset; however, it should not supersede subject-specific expertise. This is because evaluating AI responses necessitates a certain level of fundamental subject-specific and didactic knowledge. This approach is essential for assuming responsibility for teaching activities and reducing reliance on AI tools. In this regard, it is imperative that AI competencies not be disseminated in a universally applicable manner across all academic disciplines at a university. Instead, it is essential to address the utilization of AI tools in a subject-specific manner and within the context of subject-specific didactic discussions. In the context of the UNESCO Framework for AI Competencies for Teachers (Cukurova & Miao, 2024), this approach is of crucial importance in the context of the aspects "AI Fundamentals and Applications" and "AI Pedagogy," as the focus here is on the purposeful and student-centered use of AI tools within learning and teaching arrangements. The author posits that this objective is unattainable for teachers who possess only general AI competencies.

Subsequent to the filtration of AI outputs, the insights into preconceptions and their corresponding methodologies for remediation can be regarded as being of inestimable value. A substantial amount of accurate and meaningful information is provided that can be used in the design, implementation, and evaluation of learning and teaching arrangements. Furthermore, insight into the concept of preconceptions can be gained expeditiously; however, this insight must be deepened through a more in-depth examination of the topic, particularly by teachers who teach or will teach the fundamentals of electrical engineering.

The next step in the research activities will be to examine the seven conceptual models with regard to their suitability for systematizing preconceptions. The objective of this study is to develop a diagnostic instrument that will assist teachers and encourage additional research on preconceptions in electrical engineering. The employment of AI instruments is poised to assume a pivotal function within this process. The integration of AI competencies with the study of preconceptions in electrical engineering is already taking place at the university where the author of this paper is employed as a faculty member. The development of a seminar concept for (future) teachers, one that can also be applied to other disciplines, is another goal of the author's future research and teaching activities.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The author declares that DeepL Write and ChatGPT were used in proofreading and refining the language used in the manuscript. The usage was limited to correcting grammatical and spelling errors and rephrasing statements for accuracy and clarity. The author further declares that, apart from DeepL and ChatGPT, no other AI or AI-assisted technologies have been used to generate content in writing the manuscript. The ideas, design, procedures, findings, analyses, and discussion are originally written and derived from careful and systematic conduct of the research.

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