OPPORTUNITIES AND CHALLENGES OF CHATGPT IN CHEMISTRY: NARRATIVES OF PHILIPPINE PRE-SERVICE TEACHERS

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Abstract

Chemistry, especially redox chemistry, has always presented complex challenges to learners as it expects them to work at several different levels of representation and to connect abstract electron transfer processes to actual phenomena in the real world. These obstacles are compounded in pre-service teachers by the fact that they have to master disciplinary material and at the same time, start forming their own professional pedagogical identities. The study examined how twenty-five first-year teacher education students in a Philippine state university interacted with the ChatGPT as a preparatory intervention to learn the redox reactions and how these perceptions were reflected in their written responses to determine the cognitive and professional consequences of such experience. Using qualitative content analysis, six interrelated themes were generated that describe how students experienced ChatGPT as a learning scaffold, its conceptual affordances, perceived limitations, and its implications for their emerging professional identities. The findings suggest that the use of ChatGPT as a self-directed inquiry and contextualized learning scaffold is valuable, but it requires critical assessment and careful incorporation to avoid misconceptions and overdependence. For teacher education, the research explains that in order to make AI literate, teacher education should also be subject mastery that would enable future teachers to use generative AI in a responsible manner and maintain the human-centered, relational, and ethical aspects of teaching that cannot be technologically-enhanced.

Keywords: redox reactions, ChatGPT in chemistry, chemistry content analysis, ethical AI in education.

INTRODUCTION

Chemistry has long been regarded as one of the most demanding branches of science education [1], [2], largely because students are expected to integrate knowledge across macroscopic, microscopic, and symbolic levels of representation, a task that often leads them to depend on rote memorization rather than developing real conceptual understanding [3], [4], [5]. Oxidation–reduction (redox) reactions are especially challenging: they require understanding electron-transfer processes, skill in balancing equations, and correctly identifying oxidizing and reducing agents; these difficulties appear consistently in secondary and tertiary education worldwide [6], [7].

Furthermore, these chemistry-based challenges are magnified when students are unable to connect abstract representations with real-world phenomena such as corrosion, respiration, or the functioning of batteries, resulting in fragmented knowledge that resists transfer to new contexts [8]. For pre-service teachers, the difficulty is doubled, as they must not only overcome these conceptual barriers themselves but also begin developing the pedagogical skills needed to make such content accessible to their future learners [9].

In response to these long-standing difficulties, educators have increasingly explored new teaching strategies and digital tools, with generative artificial intelligence (AI) standing out as one of the most notable innovations [10], [11]. Applications like ChatGPT are now influencing how students and teachers approach learning [12], [13], [14]. Teachers have noted that such tools can support inquiry-based learning by giving structured explanations, clarifying confusing points, and supplying examples that make abstract content more approachable [15], [16], [17]. Yet, scholars also warn that without careful checking, the answers may be too simplified or even inaccurate [18], [19].

Bringing AI into teacher education presents both benefits and risks [20], [21]. While these tools can enrich learning, they also demand a cautious and critical approach [22], [23]. For pre-service teachers, the challenge is twofold: they are learners who can use AI to strengthen their understanding, but they are also future educators who must demonstrate how to apply such technologies responsibly in their own teaching [24].

In chemistry education, this balance is particularly critical. A study noted that "generative AI systems like ChatGPT can support students in exploring chemical concepts such as oxidation and reduction by providing interactive discussions that connect theory with real-world contexts." [25]. These dialogues may aid review, but the tool's reliance on patterns rather than reasoning risks producing errors that appear convincing[26]. This reliance risks reinforcing misconceptions when AI responses are not verified [27]. Consequently, teacher education programs in the Philippines must emphasize AI literacy, helping pre-service teachers to "develop critical thinking and information literacy skills that serve as society's primary defense against misinformation." [28].

This study investigates how emerging technologies, specifically ChatGPT, can be used ethically and effectively to help pre-service teachers learn redox chemistry. It examines how AI use affects students' confidence, understanding, and problem-solving, particularly where quick automated answers might compete with genuine comprehension. The research also stresses that technology cannot replace the emotional and relational aspects of teaching. Chemistry teachers, for example, must still rely on empathy, sound judgment, and professional discretion in guiding learners. These elements of teaching remain essential even as AI tools become more common in classrooms.

Thus, this paper considers generative AI as an addition to human instruction rather than its substitution when properly used. By concentrating on the elements of human accuracy, fairness, and the professional identity of the teacher, the study aims to add to the understanding of how future teachers will interact with AI as a learner and as a knowledgeable trainer. It is also aimed at educating teacher education programs about the way pre-service teachers can be trained to be knowledgeable and responsible to use AI in a wise way that empowers and does not dominate the human core of the learning process. In particular, it aimed to determine the effect of ChatGPT on (a) conceptual knowledge of redox reactions among students and (b) the future teachers with a growing professional attitude.

In this regard, a number of interconnected issues arise. First, pre-service teachers still have difficulty in accessing and organizing information in chemistry in a manner that facilitates conceptual learning, especially of abstract concepts like redox reactions. Second, digital tools can refine and deepen the understanding of the basic knowledge, but their explanations can be inaccurate or oversimplified and reinforce the misperceptions. Third, the increased use of AI becomes an emotive and professional issue to future educators, especially with overreliance, loss of agency, and the role of teachers in the technology-filled classroom. Combining these issues follows to the necessity to investigate the actual experiences of pre-service teachers with AI-based learning in the cognitive, affective, and professional aspects of it.

Essentially, the paper analyzed the experiences of pre-service teachers on using ChatGPT as a pre-learning aid in teaching redox reactions. Based on their written thoughts, six connected themes could be identified, including the availability and scope of information, the ability to elaborate on concepts, the development, and strengthening of existing knowledge, the perceived limitation and accuracy, professional and emotional reflections, and the unreliability of teachers. These themes show how students were able to make meaning out of redox concepts as they reflected on their future as teachers. More to the point, this would assume that technological learning is not merely a cognitive endeavor but rather a professional and ethical experience that can be cultivated through the human faculty of judgment, reflection, and responsibility.

METHOD

Research Design. This study used qualitative content analysis to examine how first-

year teacher-education students described their use of ChatGPT as a pre-activity for learning redox reactions. Content analysis was chosen because it enables a systematic examination of written accounts, facilitating the identification of recurring patterns, categories, and overarching themes that shed light on both the cognitive and professional dimensions of students' interactions with AI in a chemistry learning context [29]. The design is aligned with the research's objective of exploring how generative AI contributes not only to conceptual understanding but also to the developing professional perspectives of pre-service teachers.

Participants. The participants consisted of 25 freshmen enrolled in a chemistry course at a Philippine state university during the 2023-2024 academic year. Participants (n = 25) were purposively sampled as beginning teacher candidates encountering basic tertiary-level chemistry concepts, including redox reactions. Their role as pre-service teachers made their experiences particularly important because they were simultaneously learners of chemistry and future educators who reflect on the pedagogical potential of AI tools.

Research Context. The research was conducted in the course of chemistry, where redox reactions were introduced as part of the curriculum. Before the classroom discussion, students were instructed to use ChatGPT as a pre-activity learning tool. They were instructed to prompt ChatGPT for definitions, principles, and examples of redox reactions and to document their learning process. This activity was designed to simulate self-directed inquiry while providing a basis for reflection on the opportunities and challenges of using AI for science learning.

Data Collection. Data were collected through written narratives submitted by the students. Each participant was asked to respond to open-ended prompts such as:

1. What explanations did ChatGPT provide about redox reactions?
2. How did ChatGPT help you clarify or reinforce your understanding of the topic?
3. What challenges or limitations did you encounter in using ChatGPT?

4. How do you reflect on the role of ChatGPT in relation to teachers and your future profession?

These stories were collected following the pre-activity and formed the major set of data to be analyzed. Individual prompts were crafted to generate thoughts that were consistent with definite dimensions of analysis which subsequently prompted the development of themes. The initial prompt was mostly in reaction to the accessibility, scope of information and conceptual explanations. The second prompt helped in clarification and reinforcement of basic knowledge. The third prompt encouraged the students to express perceived constraints, imprecision, and challenges of using ChatGPT. The fourth prompt evoked emotional, professional, and ethical considerations with the opinions of students on the place of teachers compared to AI. Although the themes were not pre-defined, these prompts helped students focus their thoughts on the cognitive, affective, and professional levels, which were then narrowed with the help of inductive content analysis.

Data Analysis. The narratives were analyzed using qualitative content analysis [30] with the following steps:

Preparation – Reading all narratives repeatedly to gain familiarity with the data.

Open Coding – Identifying meaningful units of text that captured students' experiences and reflections.

Categorization – Grouping codes into subcategories, then into broader categories that reflected common ideas.

Theme Generation – Abstracting categories into overarching themes that captured the essence of students' narratives.

Through this process, six major themes were identified: (1) accessibility and breadth of information, (2) clarification and conceptual understanding, (3) reinforcement of foundational knowledge, (4) perceived limitations and accuracy concerns, (5) emotional and professional reflections, and (6) the irreplaceable role of teachers.

Ethical Considerations. Ethical standards for educational research were strictly followed. Informed consent was obtained from all

participants, who were assured that their participation was voluntary [31]. They could withdraw at any time without penalty. To protect confidentiality, students' names were replaced with pseudonyms when citing excerpts from their narratives. The research followed institutional research ethics guidelines, ensuring that participants' dignity and academic welfare were protected [32].

RESULTS AND DISCUSSION

The content analysis of freshmen teacher education students' narratives on using ChatGPT as a pre-activity in learning redox yielded six major themes: (1) accessibility and breadth of information, (2) clarification of concepts, (3) reinforcement of foundational knowledge, (4) perceived limitations of AI explanations, (5) emotional and professional reflections, and (6) the role of teachers in the AI era. These themes illustrate both the opportunities and challenges of integrating generative AI into science learning, particularly in chemistry, where students frequently encounter abstract and complicated concepts.

Theme 1: Accessibility and Breadth of Information

Students consistently identified ChatGPT as a highly accessible and comprehensive source of information. They appreciated its immediacy, range of examples, and ability to explain concepts that mirrored textbook explanations, particularly those found in Raymond Chang's chemistry text.

One participant reflected:

"...the explanations that it gave me were a lot like those in the book, especially when it showed how oxidation and reduction happen at the same time in a reaction; the formulas were clear, but I had to read them again and again to really follow how the electrons were transferred...." (Student 13).

Many students described ChatGPT as an easily accessible tool for explaining chemistry concepts, which boosted their confidence in topics such as oxidation numbers, titration, and electron transfer. Immediate responses from ChatGPT encouraged students to continue exploring via follow-up prompts, promoting self-directed

learning and increasing their readiness to study redox topics.

Conversely, some students found ChatGPT's responses overwhelming: the abundance of technical terms forced them to unpack answers step-by-step, which sometimes produced cognitive overload and weaker foundational understanding. This result is corroborated by recent studies, which suggest that while AI expands access to information, unfiltered responses may cause cognitive overload if proper guidance is lacking [28], [33].

Therefore, integrating AI tools into chemistry instruction still requires careful consideration of their potential uses and risks, particularly by the human teacher as the facilitator of learning in the classroom [34], [35]. As a cognitive aid, ChatGPT is most useful when a teacher facilitates its use, incorporates well-structured prompts, and adds focused supplementary tasks [36], [37]. Scholarly literature has shown the value of scaffolding to reduce the risk of misunderstanding and help students work constructively with difficult content when using generative AI as a tool [10], [16]. In this way, pre-service teachers can gain content knowledge, develop the ability to critically evaluate and contextualize the use of ChatGPT in teaching, and understand the value of integrating technology ethically in their future teaching. Well-designed scaffolding enables technology to engage and motivate students rather than frustrate them with excessive or poorly matched content [38].

Theme 2: Clarification of Concepts

Students used ChatGPT not only as an information repository but as a conversational tool where questions could be clarified and misunderstandings corrected. Through several prompt modifications and asking for more precise explanations through examples, they transformed the discourse into an interactive, inquiry-driven conversation. For example, one student reported,

"So, I asked ChatGPT to summarize what happens in a redox reaction...like how to tell which element is oxidized and which one is reduced...and the answers became clearer, but I still asked follow-up questions to be sure I understood the process." (Student 4).

Conversations between learners and ChatGPT showed how students can take a more active role in developing what they learn. Instead of just receiving information, they can question, clarify, and test ideas until these begin to make sense in their own way. Through this process, they do not simply absorb content but participate in building understanding, guided partly by curiosity and partly by the back-and-forth of dialogue.

This way of learning reflects Vygotsky's concept of the zone of proximal development (ZPD). As described in some studies, [39] the students' independent learning process can deliver them to the next level of their respective zone of potential development" (p. 6). In other words, learning happens most effectively when students explore ideas just beyond their current grasp, with some form of support or scaffolding. Generative AI tools like ChatGPT can provide that kind of support by providing prompts, explanations, or simple analogies that can help learners connect what they already understand with what they are still figuring out. In this sense, the learning process becomes both independent and AI-assisted, balancing freedom with structure.

Recent studies echo this view, noting that generative AI tends to promote exploration through cycles of questioning and revision. When students are encouraged to reframe questions, compare responses, or ask for clearer explanations, they gradually refine their understanding of various scientific concepts [40]. This type of interaction shifts learning away from memorization and toward genuine meaning-making, something especially valuable in subjects that rely on abstract thinking, such as chemistry.

Unlike static materials such as textbooks or recorded lectures, ChatGPT responds to the learner's input in real time. It can rephrase definitions, provide examples, or contextual explanations to suit different levels of understanding [41], [42]. For learners who need to see an idea in multiple ways before it "clicks," this flexibility can make a substantial difference. Studies on digital learning environments have shown that such adaptive feedback increases engagement and encourages evaluative thinking,

provided the learner receives proper guidance [43], [44].

For pre-service teachers, using ChatGPT goes beyond understanding scientific concepts like redox reactions. It also becomes a form of practice—an early chance to explore how technology might support inquiry-based teaching. These experiences help them see both the possibilities and limits of AI in education: how it can assist in clarifying ideas, but also how meaningful teaching still depends on interpretation, empathy, and judgment.

The benefits for future teachers seem to occur on two levels. First, AI explanations can strengthen their grasp of content that once felt abstract or confusing. Second, they start to imagine how digital tools could be used in classrooms to make learning more interactive and student-driven [45], [46]. Such experiences remind teacher education programs to integrate AI critically and ethically. As studies [38], [47] suggest, innovation should always go hand in hand with the cultivation of human qualities—such as fairness, empathy, and reflection. Similarly, one study [48] warn that without thoughtful pedagogy, technological proficiency can lead to dependence rather than empowerment.

Because of this, the role of generative AI in classrooms should be approached with care. It should never be seen as a shortcut or a substitute for real learning, but rather as a tool that invites curiosity and reflection [33]. When guided by teachers who value both technological fluency and human connection, tools like ChatGPT can bridge abstract scientific concepts with meaningful classroom experiences—keeping education grounded in understanding, empathy, and genuine engagement.

Theme 3: Reinforcement of Foundational Knowledge

ChatGPT supported the understanding of the fundamental concepts of chemistry among the students of oxidation, reduction, stoichiometry, and titration. These explanations frequently had examples that related abstract processes to real-life examples such as corrosion, batteries, photosynthesis, and water testing:

"In acid-base titration and redox titration, the primary difference lies in the fact that in redox titration, the protons are actually transferred between the titrant and the analyte (as opposed to protons transfer in acid-base titration)..." (Student 19).

"When ChatGPT explained to me that oxidation is losing electrons and associated it with metal rusting, it was the first time I understood the concept clearly why rusting is a redox reaction." (Student 6)

This type of reinforcement suggests the significance of the contextual basis to chemical education where the connection between the abstract representations and the real-life phenomenon helps learners go beyond mere memorization and begin to comprehend the concept in a more profound way because the tool offered means of letting learners experience the abstract chemical concepts through the multiple layers of progressively familiar representations that turned out to be less scary and more meaningful [35], [49].

By being exposed to the explanations that were not held within the formulaic definitions but rather were related to the familiar examples like the corrosion of metals, the way household batteries work, or the natural cycle of photosynthesis, the students could rebuild their previous knowledge in ways that provided the concepts with a sense of coherence.

This type of reinforcement is a sign of what new research states that contextual grounding is of significance in chemical teaching. As soon as learners are able to associate the abstract, symbolic language of chemistry with the tangible, realistic examples, they are less prone to misunderstand the essential concepts and are better able to reason at a higher conceptual level [50], [51]. In this respect, ChatGPT did not simply regurgitate information that could be located in a textbook. It acted as an adaptive study tool that enabled students to reexamine challenging material in multiple angles until such concepts started to form a cohesive sense.

In the case of pre-service teachers, the experience provided them with benefits that possibly went beyond just the cognitive. It shaped the attitude they had towards the very process of teaching. As the concept of redox reactions became clearer, most of them started to realize how useful it is to have real-life and relatable examples in the classroom. Many of them commented that by placing chemistry in the context of something familiar (e.g. water-quality tests, or everyday examples of electron transfer), chemistry would seem less daunting and more approachable in their future students.

ChatGPT in this sense was not an alternative to the teacher, but a scaffold to fill the gap existing between what these pre-service teachers knew as learners, and what they hoped to become as educators. It strengthened comprehension and paradigmed reactive explanations in regard to various learners. The support offered by AI, in turn, was not an isolated event but a continuous one, one that helped to build knowledge and foster thought, as well as show how contextualization could help to turn abstract knowledge into meaningful, long-lasting knowledge.

Theme 4: Perceived Limitations of AI Explanations

Nevertheless, regardless of its advantages, students identified significant weaknesses in the explanation provided by ChatGPT. Others found factual errors or ambiguous phrasing, especially in their attempts to differentiate between oxidizing and reducing agents or when attempting to go to simplified answers:

"Redox titration It is a process in which you measure the temperature change on a substance and use it to know its concentration. However, on looking up my notes I saw that was not right...it has to be electron transfer and not heat measurement..." (Student 4).

Students also reported challenges that interfered with their learning about redox reactions. Since they are about to become the teachers of science, they realized that precision and consistency are vital in chemistry, so even minor mistakes can lead to confusion. As an example, when ChatGPT got the definition of a redox titration mixed up with a calorimetric process, it did not only reveal how the model is susceptible to factual error, but it also showed how dangerous it

is when students do not learn to be conscious of what they read and to cross-check it.

There were some students who saw the discrepancies between the answers that AI gave and the information in textbooks or lectures. They did not surrender to those discrepancies; they were angry and emphasized that they had to compare answers of the tool with credible sources. This capability to identify discrepancies was an attribute that a study defined as the development of information literacy [52], a vital ability in the digital era when knowledge is pervasive but disparate in quality and demonstrates that learners were starting to be more critical rather than uncritical consumers of AI productions [51].

Simultaneously, the thoughts of students revealed that even the drawbacks inherent in ChatGPT were used in an unforeseen way to form their academic behaviors, as they came to understand the faultiness of the tool created an incentive to engage in a more critical perspective on all forms of learning resources, both digital and conventional. Some of the participants indicated that they encountered errors or over simplifications that did not undermine the value of the tool. Instead, such instances brought them to mind the necessity to cross-check the information by referring to the textbooks, lecture notes, or other credible sources.

This process became an experience of learning to many people; it helped them think more critically, compare points of view and feel more ownership over their learning. It proves that, counterintuitive as it may sound, the shortcomings of AI can turn into a productive force that encourages learners to develop their critical thinking and learn to recognize the invaluable importance of human experience in helping them navigate the intricate material of any topic. The skill of questioning AI acquires professional significance in the case of pre-service teachers: the more they train to think critically themselves, the more they start to know how to teach the following generation to be more caring and considerate towards the use of technology [53], [54].

Theme 5: Emotional and Professional Reflections

Emotional and professional issues regarding the role of AI in education were also present in the accounts given by the students. Some found speed and clarity of ChatGPT to be an advantage, whereas other people felt uneasy about this system, as it affected education:

"I felt empty after finding that AI could instantly solve redox equations and explain oxidation numbers, it made me wonder if I was really learning or just depending on it too much..." (Student 12).

"Regardless of all the advantages of using AI tools, such as ChatGPT, I came to the realization that teachers are still valuable, and, in particular, they can explain the reason different substances are oxidizing or reducing agents, which AI cannot personalize to everyone." (Student 18).

Therefore, the new technologies in learning settings have been associated with both excitement and anxiety in equal measure. In their remarks, pre-service teachers mentioned the usefulness of AI but also discussed how AI and automation will make their professional identity and role in the classroom more complicated [17], [55].

The emotional ambivalence of students is an example of the complexity of AI in education: students understand the fact that efficiency will be increased with the help of such tools as ChatGPT, but they also experience fear of the impact that technology will have on the relations and roles in teaching [37], [49]. That is the core of the relational technology problems in education: the role of technology in transforming the relationships and roles between people who are engaged in the process of learning. Researchers have observed that educational technologies tend to bring up the issue of the decline of long-standing teaching practices, and the frequent inability to achieve promised efficiencies [56], [57]. The case of AI in education represents the perfect mix of relational, cultural, and social problems of trust, power, and human involvement in the learning process.

To illustrate, a group of pre-service teachers making a lesson about chemical bonding with the help of ChatGPT could be considered. The tool provides them with simplified explanations and preparing ready activities, which at first glance appear useful in terms of saving time. But when

they consult these materials in comparison to their textbooks and classrooms they see that there are simplifications which are likely to be misleading their further students. This experience makes them ask themselves a question: Do they rely on the performance of AI, or do they spend time on enhancing and modifying the material themselves? They understand that their work as teachers does not simply involve provision of information. They must also make sure that it is accurate, contextual, and establish human relations that cannot be substituted by AI. These experience will contribute to the knowledge of future educators that although AI may be a useful tool, it must be carefully judged and used with caution in order to be actually helpful in supporting learning.

Theme 6: The Role of Teachers in the AI Era

Lastly, students pointed out that, though AI is a useful supplement, teachers cannot be replaced. They appreciated human teachers because they put learning into context and inspired the students as well as giving them emotional and moral directions. As one narrative stated:

"AI can supplement instruction but cannot replace human teachers, especially in contextualizing chemistry content and providing relatable examples." (Student 23).

The narrative affirms that no matter how advanced technology becomes, the role of the teacher remains central. Real learning happens through human connection—something no machine or program can truly replace [58]. To students in this research, the relational, motivational, and interpretive features of teaching are crucial, especially in science education where concepts need to be related to larger life and moral contexts. These considerations are congruent with the theory that the adoption of technology must empower human agency throughout the teaching and learning process [55].

Combined, the six themes signify that ChatGPT is simultaneously a cognitive aid as well as a reflection catalyst. On one side, it helped to make it accessible, understand complicated concepts better, and strengthen the background. Conversely, its inaccuracy and limitations also led to students being thoughtful of the tool and their roles as future teachers. This duality not only

represents the potential of AI but also the necessity to teach about AI in the pedagogical frameworks that prompt students to critically assess, but not blindly consume, AI-generated knowledge.

Such results are in line with wider research, which helps to understand why AI must be admitted as an auxiliary pre-activity resource and not an alternative to conventional education [53]. In the case of teacher education, the findings outline the two-fold issue: (a) pre-service teachers must have a high level of mastery in the subject matter, and (b) pre-service teachers need to become AI literate to be able to responsibly incorporate the use of tools such as ChatGPT without affecting accuracy or relational pedagogy [54]. These competencies are especially important to develop in such situations as chemistry, when the wrong understanding of scientific concepts can have a trickle-down effect on subsequent teaching.

The reflections of freshmen teacher education students are corroborated in the Philippine context, where the teacher-student relationship is a highly praised concept (AI cannot be excluded as a way of improving the learning process), but must be incorporated into the human-centered approach to pedagogy [59]. The issue facing curriculum developers and teacher educators is how to equip prospective educators to be content-competent and digitally literate educators who can possess the ability to balance technological efficiency with the human values of teaching. Also, students value the affective and moral aspects of education the most that AI is unable to reproduce [15], [16]. The implementation of AI should, therefore, not be prohibited, but serve as an addition to the human value of the teachers who cannot be replaced.

CONCLUSION

This paper investigated the experience of 25 pre-service teacher freshmen working with ChatGPT as a learning pre-activity tool in redox reactions, including matters of conceptual involvement and developing professional outlooks. Their written narratives were analyzed and found six themes that are interrelated and describe the interaction of students with generative AI with reference to chemistry learning, information evaluation, and reflection on their future roles as

teachers. Instead of looking at the use of AI as a single experience, the findings demonstrate how the engagement of the students occurred to them at the cognitive, affective, and professional levels.

In terms of cognitive topics, such as access to and depth of information, explanation of concepts, and reviewing basic knowledge, students claimed that ChatGPT is an easy-to-access support to the learning process. Respondents said that they used the tool to find some definitions, explanations, worked problems, and summaries of abstract redox processes like electron transfer, oxidation numbers, and identification of oxidizing and reducing agents. These attributes were linked to the perceptions of students in overcoming some of the early stages of learning in cases where they face unclear terminology or symbolic representations. The repeated question and rephrasing of the prompts were also defined by the students, as evidenced by the change in how they expressed their ideas about the redox concepts, such as using more examples and making connections to real-life chemical processes.

Besides this, the narratives of students also indicate that ChatGPT served as a system of re-experiencing and rearranging earlier knowledge. Having been exposed to reductive-oxidative reactions in the context of corrosion, batteries, or titration, students reported re-learning some of the basic chemistry facts in a manner that seemed more integrated to them. All these experiences were linked to the shifting of the characteristics of descriptions of the learning process among the students toward less-memorized-rule-based explanations. Nevertheless, these changes were presented by students as testable and conditional instead of as a consequence of knowledge.

In addition to these cognitive experiences, students described a number of shortcomings of AI-generated explanations. The stories contained accounts of factual errors, vague wording, simplistic explanations, and cases of information overload, especially when the AI output was different than the textbook or classroom learning. Students said that they addressed these problems by looking at notes, referring to reference materials, or asking for clarifications during classroom discussions. These practices suggest the importance of critical analysis and verification to AI-based learning situations, particularly those in chemistry, where conceptual accuracy is required in true understanding and learning.

In addition to the cognitive aspects, the results demonstrated a variety of emotional and professional thoughts about the use of AI. Students were ambivalent in their feedback, which not only shows admiration for the efficiency and convenience of ChatGPT, but also worries about overreliance, decreased effort, and doubt regarding the level of their personal learning. These emotional reactions were also related to the thoughts about professional identity, as the participants thought about what the usage of AI can imply for them in their future as teacher. Instead of stating that they are either unconditionally accepting or unconditionally unaccepting of AI, students reported negotiating its role in their conceptualization of responsible teaching practice.

In all of these reflections, human judgment, contextual explanation, and ethical responsibility in education were often mentioned by students. According to the participants, teachers were described as key actors in mediating learning, fixing misunderstandings, and helping students to do things that they saw as not within the capabilities of AI tools. These perceptions imply that AI was not introduced as a substitute for a teacher but as a tool that will have its value determined by its guidance, interpretation, and integration into a teaching process.

The themes put in combination make ChatGPT a learning tool and a reflection point on professional practice. Its use was linked with conceptual involvement even as it encouraged students to reflect on matters involving accuracy, accountability, as well as the changing aspect of a teacher in technology-enhanced classes. In the case of teacher education, the results suggest that AI literacy needs to be considered in conjunction with subject-matter preparation, especially in a subject like chemistry, where the misconceptions can potentially have significant long-term instructional implications.

Curricular and policy-wise, the findings show the applicability of teaching how to use AI responsibly in teacher education programs. Faculty members can be involved in such modeling practices as verification, contextualization, and reflection on AI-assisted tools. Finally, the usefulness of ChatGPT as a preparatory learning tool is seen, but its educational value remains subject to how it will be incorporated into the instructional practice and mediated by the professional judgment and pedagogical decision-making of teachers.

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