Enhancing Instructional Design: The Impact of CONALI Ontology and ChatGPT in Primary Education Training

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Abstract

The integration of Artificial Intelligence (AI) in education is becoming increasingly crucial [1], especially for the preparation of future educators. Despite these requirements, there is a paucity of training courses for educators in the use of AI systems [2]. AI-driven tools play a crucial role in personalizing, simplifying, and innovating educational pathways at all levels [3]. his study examines the combined application of the CONALI Ontology [4][5] and ChatGPT in supporting the instructional design process among 110 students enrolled in the Primary Education Sciences Laboratory at the University of Foggia. The goal was to evaluate how AI can enhance the creation of Learning Units (LUs) by streamlining design processes and promoting educational innovation. Participants received training in using the CONALI framework, which emphasizes the identification of learning objectives, activities, and assessment methods through constructive alignment [5]. After this initial instruction, students engaged in the design of their own LUs, integrating ChatGPT as a support tool. At the conclusion of the exercises, validated questionnaires were administered to assess participants' perceptions of the implementation of the CONALI ontological framework in combination with generative AI systems ChatGPT. The goal was to explore the advantages, disadvantages, and emerging challenges that must be addressed in the training of future educators, specifically regarding the integration of AI in the design of Learning Units and its implications for both their current and future educational practices. Results demonstrated that the CONALI Ontology was instrumental in helping students articulate SMART objectives, resulting in clearer, more focused instructional design. Moreover, the integration of ChatGPT was perceived as significantly improving the efficiency and creativity of the design process, enabling students to quickly generate ideas and refine their projects. This study highlights the transformative potential of AI in conjunction with structured ontological frameworks to enrich instructional design, ultimately enhancing the skills and competencies of future educators in a technology-enhanced learning environment.

Keywords

AIEd; Instructional Design; Teacher Training,

1. Introduction

Artificial Intelligence (AI) systems are becoming increasingly integral to education, especially in preparing future educators to navigate a rapidly evolving technological landscape. AI refers to software and hardware designed by humans to act autonomously in the physical or digital domain by perceiving their environment through data acquisition, interpreting the structured or unstructured data, reasoning on the knowledge derived, and deciding the best actions to achieve a specific goal [6].

In the educational sphere, AI offers significant opportunities to enhance teaching methodologies, streamline administrative tasks, and provide personalized learning experiences [7]. Recent studies have shown that AI's application in education can improve teachers' work efficiency, support professional development, and foster a positive attitude towards technology in teaching contexts [8][9]. However, despite the clear advantages, there remains a paucity of research and training

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initiatives aimed at equipping future educators with the skills necessary to integrate AI systems into their pedagogical practices effectively [10].

This study aims to address this gap by examining the combined application of the CONALI Ontology and AI-driven tools, such as ChatGPT, in supporting the instructional design process. The CONALI Ontology, based on constructive alignment theory, ensures coherence between learning objectives, activities, and assessments, making it a valuable tool in educational contexts [11][4][5].

When integrated with AI systems like ChatGPT, which assist in generating, refining, and personalizing content, these tools hold significant potential for transforming how educators design and implement instructional units. The importance of such AI-driven tools lies not only in their ability to streamline complex tasks but also in their capacity to innovate educational pathways at all levels [12].

In this study, we examine how AI, particularly ChatGPT, can enhance the creation of Learning Units (LUs) by simplifying the design process and promoting educational innovation. A total of 110 students enrolled in the Primary Education Sciences Laboratory at the University of Foggia participated in this research, receiving training on how to use the CONALI framework in conjunction with AI tools.

This training focused on identifying learning objectives (LO) and Educational Goal Verb (EGV), designing appropriate Teaching and Learning Activities (TLA), and determining assessment methods that align with the principles of Constructive Alignment (CA) [13].

Upon completing the training, students applied these principles to design their own Learning Units (LUs), initially with the assistance of the CONALI Ontology, and later with the support provided by ChatGPT. This process allowed them to explore both the advantages and challenges of integrating AI into educational design.

The potential of AI in enhancing instructional design lies in its ability to personalize learning experiences, simplify repetitive or administrative tasks, and foster creativity in the development of educational materials. For instance, previous research has demonstrated that AI-based systems can provide personalized learning environments that cater to individual students' needs, thus promoting more inclusive and effective learning experiences [14]. This is particularly relevant in the context of designing Learning Units, where the combination of the CONALI Ontology's structured approach with ChatGPT's generative capabilities can help future educators articulate SMART objectives more clearly, leading to more focused and effective instructional plans [15].

Despite the benefits, there are also notable challenges in the integration of AI in education. One of the key issues is the lack of comprehensive training for educators in the effective use of AI tools [8]. While AI can automate many aspects of instructional design, such as generating lesson ideas or providing feedback on assessments, educators still need to develop a deep understanding of these technologies to use them effectively. This requires not only technical proficiency but also an understanding of the pedagogical implications of AI use in classrooms. The results of this study highlight the importance of providing future educators with adequate training in both AI tools and pedagogical strategies to ensure they can harness the full potential of these technologies in their teaching practices.

Furthermore, the findings from the questionnaires administered at the conclusion of the study revealed that students generally perceived the integration of ChatGPT and the CONALI Ontology as beneficial, particularly in terms of increasing the efficiency and creativity of their design processes. However, they also identified several challenges, including the need for more training on how to critically assess and refine AI-generated content to ensure its pedagogical relevance and quality [7]. As AI continues to play a growing role in education, it is crucial to address these challenges to maximize its potential benefits.

The integration of AI in education, particularly through tools like ChatGPT and structured frameworks such as the CONALI Ontology, holds significant promise for enhancing the instructional design process and preparing future educators for the demands of a technology-enhanced learning environment. By streamlining the design of Learning Units and promoting educational innovation, these tools can help educators create more personalized, inclusive, and effective learning experiences. However, to fully realize the benefits of AI in education, it is essential to address the current gaps in training and provide educators with the skills they need to critically engage with AI technologies in their professional practice [16].

2. Methodology

The aim of this study was to evaluate how the integration of the CONALI Ontology and ChatGPT could enhance the instructional design process among students in Primary Education Sciences. Conducted with 110 students enrolled in the Primary Education Sciences Laboratory at the University of Foggia, the study focused on guiding students through the design of Learning Units (LUs) by emphasizing the identification of educational objectives, activities, and assessment methods using the CONALI Ontology, which is based on Constructive Alignment (CA) principles [11]. The research aimed to capture both perceived benefits and challenges associated with using AI tools like ChatGPT in combination with structured ontological frameworks to support instructional design.

2.1. Study design and participant training

To introduce participants to the concepts underpinning the study, a one-hour lecture was conducted on the principles of Constructive Alignment and the CONALI Ontology. This session highlighted the importance of creating SMART (Specific, Measurable, Attainable, Realistic, and Time-bound) objectives [17][18] and aligning these with Teaching and Learning Activities (TLAs) and Assessment Tasks (ATs) to achieve coherent instructional design.

Following this, students were randomly divided into two groups to engage in practical activities:
- Experimental Group: Used both the CONALI Ontology and ChatGPT for instructional design.
- Control Group: Used only the CONALI Ontology for the same tasks.

2.2. Intervention phases

2.2.1. Phase 1: Initial design without AI support

In the first phase, both groups participated in a frontal lecture specifically on the CONALI Ontology, followed by an exercise in which they independently designed their LUs without using AI tools. This phase served to familiarize students with the instructional design process based solely on the ontology framework. Students were allotted 45 minutes to complete this task, followed by a 30-minute group discussion to address common challenges and clarify any misunderstandings.

2.2.2. Phase 2: Introduction and use of ChatGPT

After completing the initial task, a detailed 30-minute training session introduced ChatGPT as a generative AI tool to support instructional design. This training emphasized how ChatGPT could assist in brainstorming ideas, refining educational objectives, and suggesting suitable activities and assessments.
For the subsequent design exercise, the experimental group was instructed to use ChatGPT in combination with the CONALI Ontology, while the control group continued to work with only the ontology. Both groups were given 60 minutes to design new Learning Units (LUs), with the experimental group encouraged to use ChatGPT to streamline idea generation and optimize their instructional plans. After this exercise, a classroom discussion was conducted to gather qualitative feedback from both groups and to identify any notable differences in their approaches and experiences with instructional design.

2.2.3. Data collection and evaluation

At the conclusion of the exercises, a comprehensive questionnaire was administered to all participants to capture their perceptions of the instructional design process, focusing on ChatGPT's impact on efficiency, creativity, and clarity. To ensure comparability:

- The control group questionnaire focused solely on their experience using the CONALI Ontology.

- The experimental group questionnaire specifically explored how ChatGPT contributed to their ability to identify educational objectives, TLAs, and appropriate assessment methods.

The structured design of this study allowed for a direct comparison between the two groups, enabling an in-depth analysis of the unique contributions of ChatGPT to instructional design. The data collected from these questionnaires provided valuable insights into how future educators perceive and benefit from AI-driven tools in planning personalized and innovative learning experiences.

2.2.4. Limitations and considerations for future research

One limitation of this study was the lack of a pure control group that did not use either tool, which might have helped isolate the distinct effects of ChatGPT and the CONALI Ontology. Future studies should consider incorporating a baseline group to better quantify the individual impacts of each tool. Additionally, the study relied on self-reported data, which, while insightful, would benefit from being supplemented by expert evaluations or rubric-based assessments to objectively measure the quality of the produced Learning Units.

2.3. Intervention schedule

The intervention schedule was structured as follows:

1. Introduction to Constructive Alignment and the CONALI Ontology (1 hour): Presentation on aligning educational objectives and Educational Goal Verbs (EGVs) with TLAs and ATs.
2. Exercise 1 (45 minutes): Students independently designed LUs using only the CONALI Ontology.
3. Group Discussion (30 minutes): Addressing challenges and experiences from the initial exercise.
4. Introduction to ChatGPT (30 minutes): Training on using ChatGPT in educational design.
5. Exercise 2 (60 minutes): The experimental group used ChatGPT alongside the CONALI Ontology, while the control group used only the ontology to design new LUs.
6. Final Discussion and Assessment (20 minutes): Questionnaire to evaluate participants' perceptions and experiences.
7. The questionnaire responses, which include detailed analyses of participants' perceptions regarding the integration of AI tools in instructional planning, are discussed in the "Results" section.

3. Results

The results of this study are organized into two main sections, each focusing on the impact of either the CONALI framework or ChatGPT in enhancing students' instructional design skills. Both sections address quantitative data from the questionnaire responses, supplemented by qualitative insights from classroom discussions. Each figure is referenced with accompanying captions for clarity and relevance.

3.1. Design results after support from the CONALI Ontology

Download The application of the CONALI Ontology, specifically structured around Constructive Alignment (CA), proved to significantly enhance students' confidence and clarity in designing Learning Units (LUs). Key findings are organized as follows:

3.1.1. Confidence levels and understanding of CA principles

Download A notable increase in student confidence and understanding was observed. Prior to training, only 27.3% of students felt confident in their ability to design a UDA independently. Following the structured support of the CONALI Ontology, this figure rose to 85%, indicating a substantial increase in self-efficacy (Fig. 1). Moreover, familiarity with CA principles increased

from 27.3% to 83.6%, demonstrating that the ontology effectively communicated complex concepts (Fig. 2).

Before applying the CA, I felt confident in my ability to design a UDA that aligned learning objectives with assessments and teaching methods.
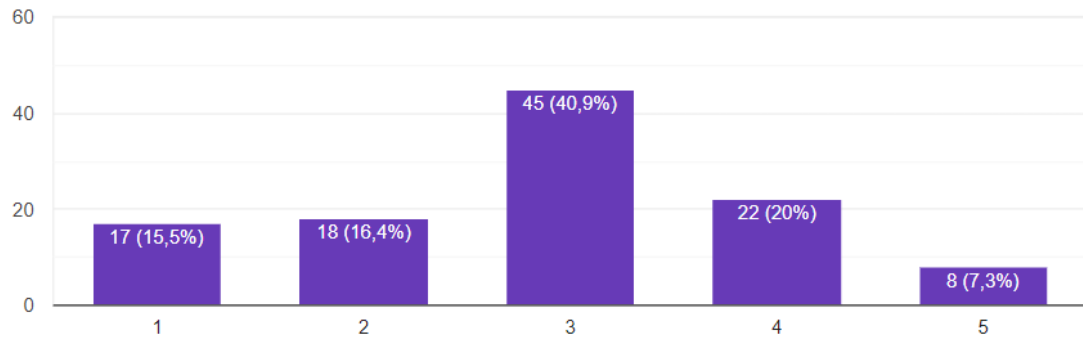
110 risposte

Figure 1: Percentage of students confident in designing a UDA pre-CONALI Ontology training.

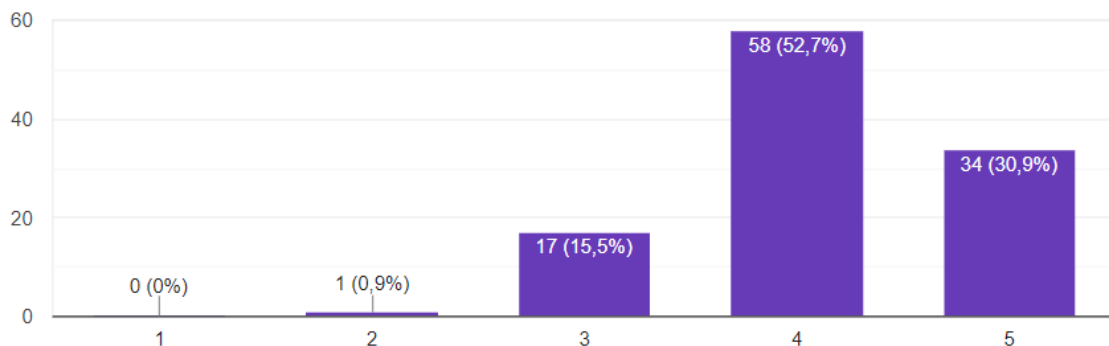After the course, I feel more capable of aligning UDA learning objectives with appropriate teaching and assessment methods.

110 risposte

Figure 2: Student understanding of CA principles after the CONALI Ontology training.

3.1.2. Application of knowledge and instructor support

The questionnaire responses revealed that 92% of students felt that practical examples in the CONALI training bridged theoretical and practical aspects of instructional design, directly applicable to future UDA planning (Fig. 3). Additionally, 88% reported that the instructional support provided during the sessions was crucial in enabling them to apply these concepts independently. This indicates that the ontology, combined with structured support, facilitated a productive learning environment.

The course provided practical examples that I can apply to UDA design.
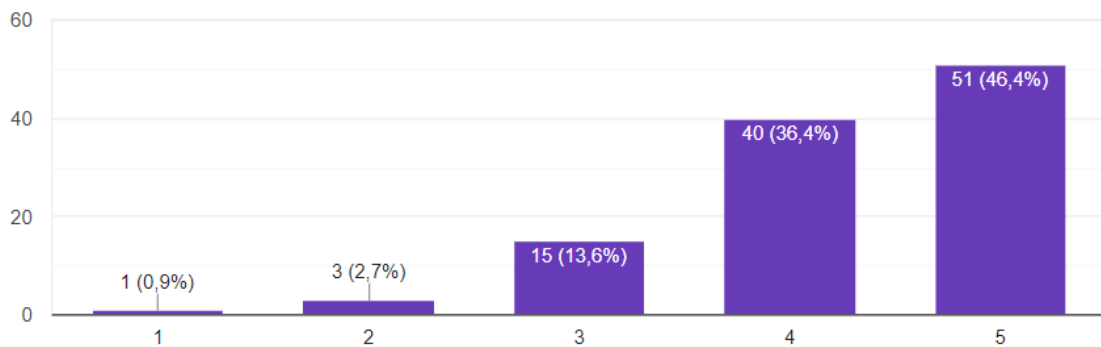
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Figure 3: Percentage of students finding practical examples in the training applicable to future UDA design.

3.1.3. Collaborative learning environment

The training's collaborative aspect also had a positive impact, with approximately 80% of students indicating that the course encouraged idea exchange and teamwork, which they found beneficial to their learning process (Fig. 4). Many students attributed their understanding of complex CA concepts to these collaborative sessions, as supported by the high satisfaction rate (85%) regarding course content and interactive format (Fig. 5).

The course encouraged collaboration and exchange of ideas among the participants.
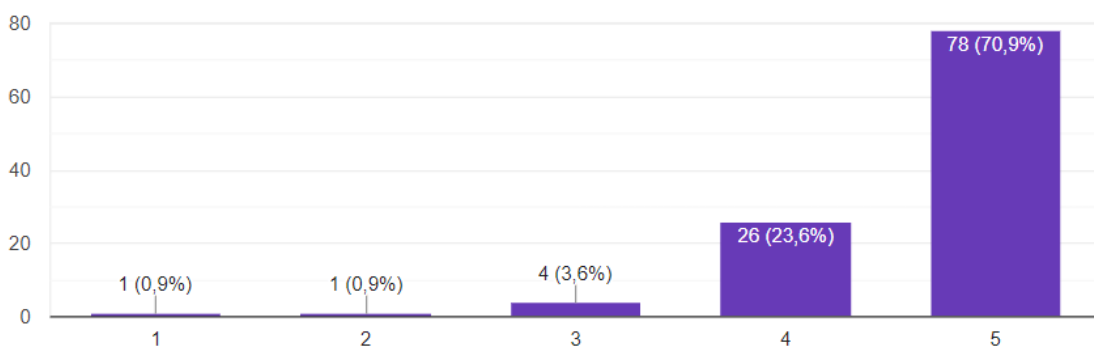
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Figure 4: Percentage of students who found collaboration beneficial to their learning.
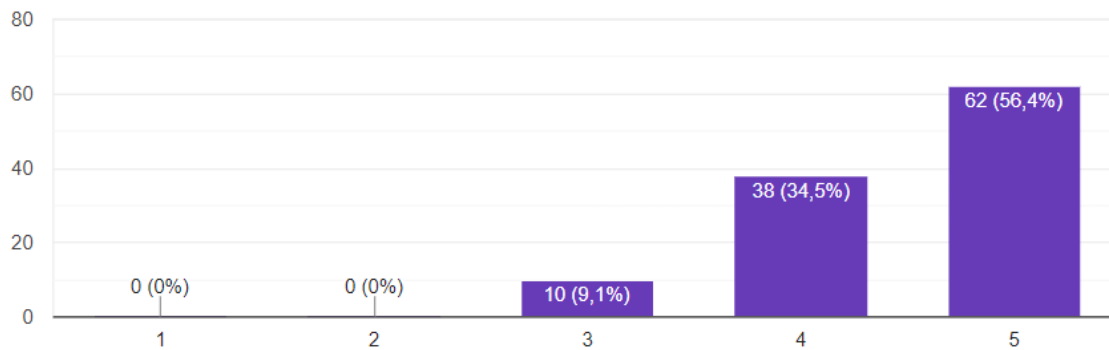
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Figure 5: Student satisfaction with course content and interactive approach to teaching CA principles.

3.2. Design results after support from ChatGPT

The integration of ChatGPT as a supplemental design tool yielded a generally favorable response, with students noting improvements in creativity, efficiency, and task clarity during UDA planning.

3.2.1. Integration into teaching practice, task understanding and satisfaction

An impressive 95% expressed intentions to apply constructive alignment principles when designing their future UDAs. This commitment suggests that students not only learned but also valued the knowledge gained during the course (Fig.6)

Approximately 90% of students reported a clear understanding of the task requirements, with ChatGPT effectively helping them delineate objectives and design requirements (Fig. 7). Furthermore, 85% expressed satisfaction with their performance in creating UDAs with ChatGPT's support, indicating its positive impact on the overall design process.
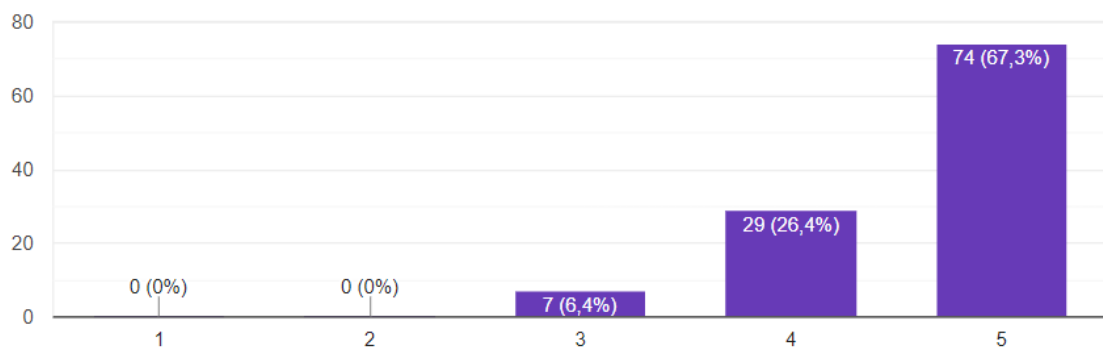
110 risposte

Figure 6: Percentage of students intending to use the CA to design future UDAs

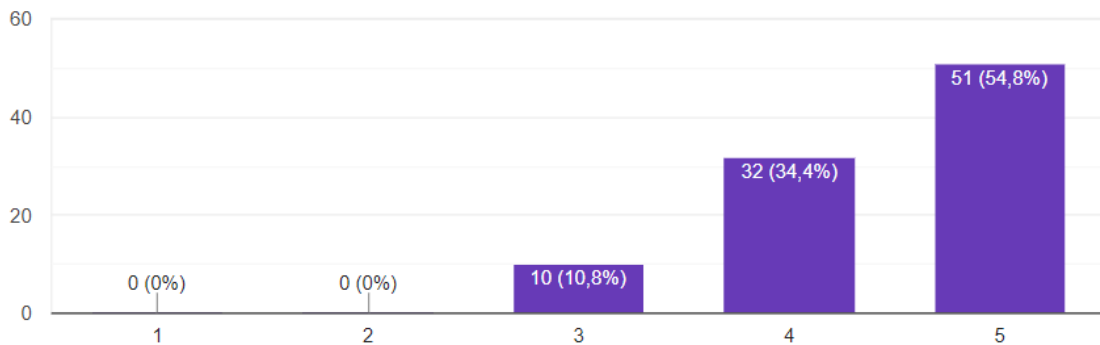Are you satisfied with how you performed the task?

93 risposte

Figure 7: Percentage of students satisfied with their UDA design process using ChatGPT.

3.2.2. Time efficiency and accessibility

In terms of time efficiency, students reported an average completion time of two hours for UDA design, noting that ChatGPT expedited brainstorming and helped them organize their ideas more effectively. Most students accessed the free version of ChatGPT, which underlines its accessibility as an educational resource.

3.2.3. Impact on objective and organization

Approximately 75% of students acknowledged that ChatGPT facilitated the generation of instructional objectives and alignment with suitable assessment systems, a critical component in instructional design (Fig. 8). Additionally, 80% reported that ChatGPT assisted in structuring their ideas, making it easier to organize UDAs coherently (Fig. 9), with 70% indicating that the AI's suggestions encouraged them to pursue more refined strategies and assessments (Fig. 10).

ChatGPT facilitated the generation of objectives, strategies and evaluation systems congruent with the UDA
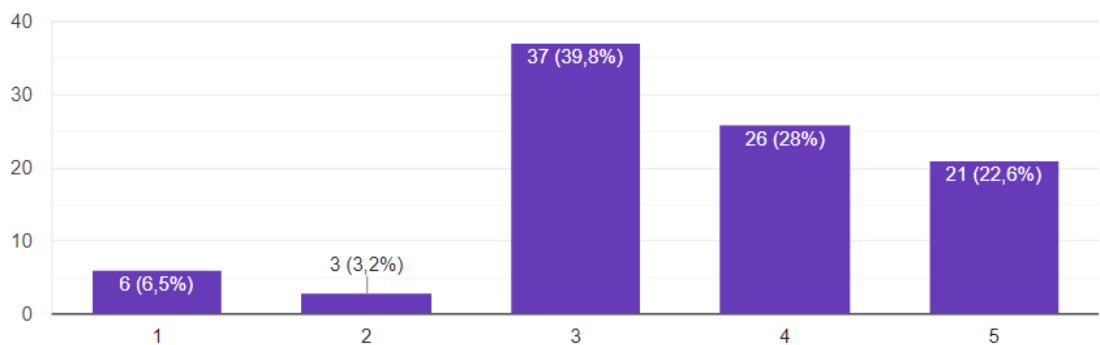
93 risposte

Figure 8: Percentage of students reporting improved objective generation using ChatGPT.

ChatGPT facilitated the organisation of my UDA design ideas   Copia
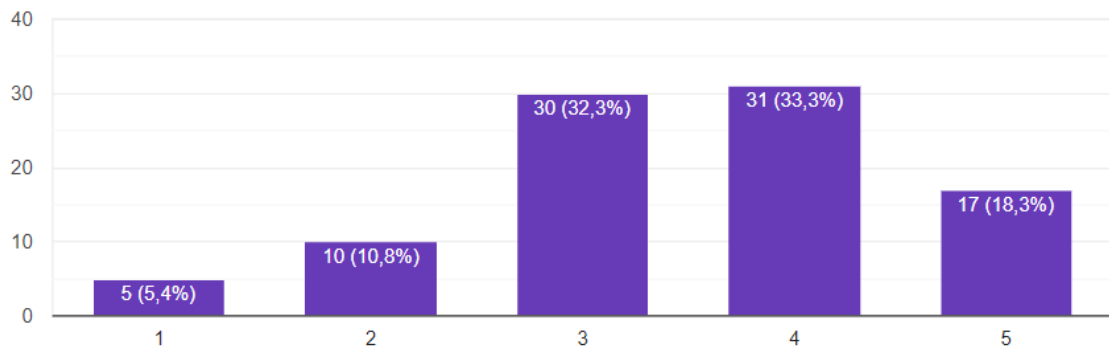
93 risposte

Figure 9: Students' perception of ChatGPT's aid in organizing their UDA structure.

ChatGPT allowed me to find more congruent goals, strategies and evaluation systems than I would have found on my own.   Copia
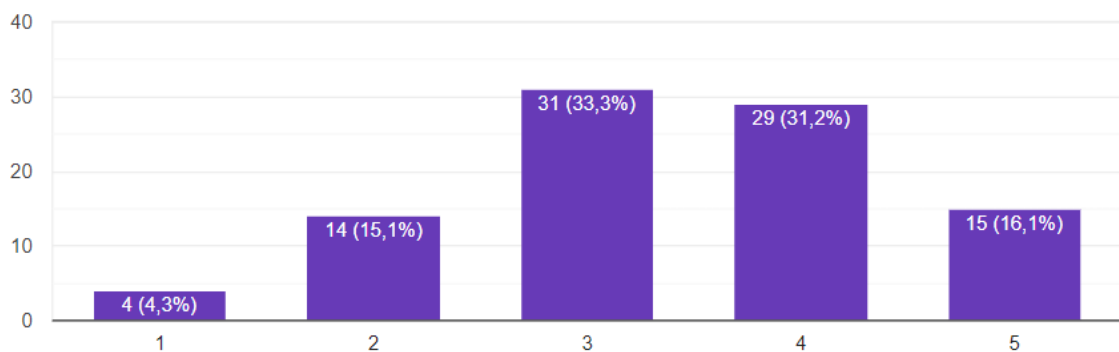
93 risposte

Figure 10: Percentage of students pursuing refined objectives and assessments with ChatGPT's support.

3.2.4. Limitations and critical thinking challenges

Despite these positive outcomes, some limitations were reported. Approximately 60% of students noted that ChatGPT's suggestions sometimes lacked contextual relevance, necessitating a careful evaluation of AI-generated content to ensure pedagogical alignment (Fig. 11). Additionally, 70% emphasized the importance of critical thinking in validating ChatGPT's output to maintain instructional accuracy and relevance.
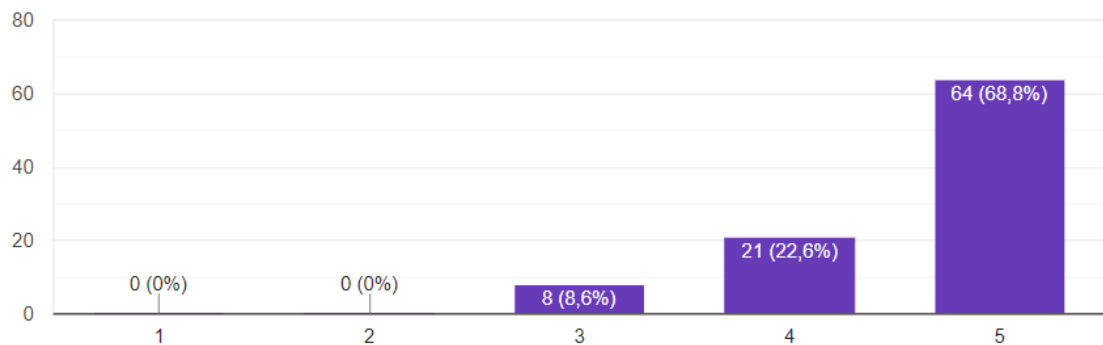
Figure 11: Students emphasizing the need for critical thinking when using ChatGPT.

3.2.5. Technical limitations and feedback on AI accuracy

Technical issues were also highlighted, particularly by students using the free version, who reported slow response times and occasional service unavailability, which disrupted their workflow. Moreover, 75% rated ChatGPT's accuracy as satisfactory, though some students noted that certain responses were generic and did not fully address their instructional goals (Fig. 12).
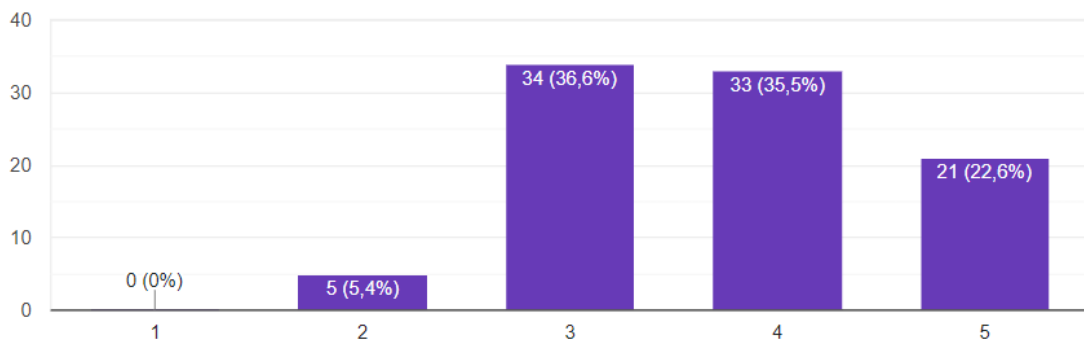
Figure 12: Percentage of students rating ChatGPT's accuracy as satisfactory or higher.

3.2.6. Technical limitations and feedback on AI accuracy

Reflecting on their experience, 85% of students considered ChatGPT a useful tool for UDA design and expressed an intent to continue using it as a supplementary resource in future instructional planning (Fig. 13). However, many cautioned against excessive reliance on AI tools, stressing the need for human oversight to preserve quality and depth in educational planning.

Figure 13: Percentage of students who consider ChatGPT valuable and intend to use it in future projects.

3.3. Summary of findings

In conclusion, both the CONALI Ontology and ChatGPT contributed to the enhancement of instructional design skills among students, each providing distinct but complementary benefits. While the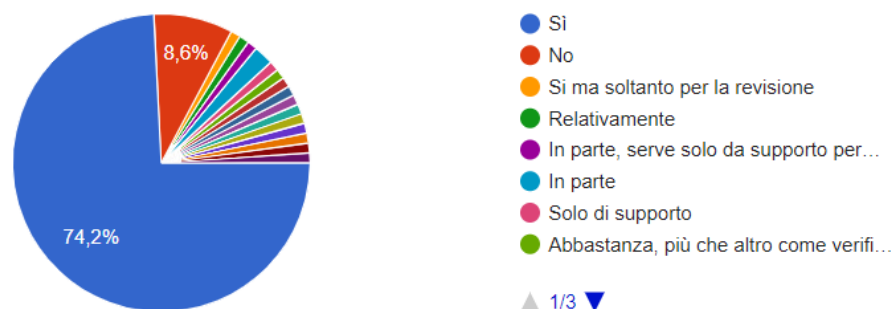 CONALI framework improved foundational knowledge of CA principles and practical application, ChatGPT offered efficiencies in creativity and organization. However, the need for critical evaluation of AI output remains essential, as does the risk of over-reliance on AI. These results underscore the potential for combining ontological frameworks with AI tools to enhance instructional design, provided that students are trained to engage critically and independently with AI-generated content.

4. Discussion

The integration of artificial intelligence (AI) tools, such as ChatGPT, alongside the Constructive Alignment Ontology (CONALI), represents a promising approach for designing Units of Didactic Activities (UDAs) in primary education training. This section explores the benefits, limitations, and challenges associated with the adoption of ChatGPT and CONALI, along with future implications for educational practices.

4.1. Summary of findings

The findings of this study highlight several distinct benefits stemming from the combined use of ChatGPT and CONALI in UDA design. Firstly, the structured support provided by CONALI significantly improved students' comprehension and application of Constructive Alignment (CA) principles. Approximately 90% of participants reported increased clarity in designing SMART (Specific, Measurable, Attainable, Realistic, and Time-bound) objectives, which directly supported their ability to align learning outcomes with targeted instructional strategies and assessments. This reflects an essential goal of CA by ensuring coherence between objectives, teaching methodologies, and assessments, a principle foundational to effective instructional design.

The introduction of ChatGPT further augmented these benefits by enhancing efficiency and creativity. As noted by 85% of students, ChatGPT helped streamline the ideation process, allowing them to focus on the depth and quality of their instructional units rather than getting bogged down by initial brainstorming challenges. In particular, 75% of students highlighted ChatGPT's effectiveness in facilitating the generation of instructional objectives and assessment frameworks. This suggests that ChatGPT's generative capacity is especially valuable during the preliminary design phase, helping students concentrate on more nuanced and pedagogically aligned choices (Fig. 7).

The observed time efficiency also represents a crucial benefit in the educational context, where both students and instructors manage demanding schedules. As most students reported completing

their UDA designs more quickly than anticipated, ChatGPT demonstrated potential as a time-saving tool, supporting its role as a complementary resource for educators and students alike (Fig. 8). Moreover, students valued the accessibility of ChatGPT, with most relying on the free version, highlighting the tool's potential as a scalable and inclusive educational asset.

4.2. Limitation and challenges in AI integration

Despite these positive outcomes, integrating AI in UDA design introduces notable limitations and challenges. A primary concern is the need for critical thinking when using AI-generated content. While 70% of students found ChatGPT's suggestions useful, many noted that personal judgment remained crucial to ensure the relevance and accuracy of AI-generated ideas. ChatGPT's suggestions, though helpful, require students to interpret and adapt them thoughtfully, underscoring a critical challenge: while AI can generate content ideas, it cannot replace human insight, which is necessary for aligning instructional design with specific educational contexts.

Technical limitations also impacted the user experience. Several students using the free version of ChatGPT encountered slow response times, which affected the fluidity of their design process (Fig. 9). Furthermore, approximately 60% of students reported that some AI-generated responses lacked specificity, indicating that the tool's generative capabilities may sometimes produce generic or contextually inadequate responses. This limitation suggests that while ChatGPT can support UDA design, it requires refinement to better address diverse and specific educational needs.

An additional challenge is the risk of over-reliance on AI. As reported by some students, ChatGPT's supportive role could inadvertently lead to dependence, with students potentially prioritizing AI-generated ideas over personal critical analysis (Fig. 11). This concern aligns with existing literature on AI in education, which emphasizes the importance of fostering independent critical thinking skills among students. If AI tools like ChatGPT are used as a substitute rather than a support, they risk stifling students' development of essential instructional design competencies.

4.3. Future implications for educational practice

The integration of ChatGPT and CONALI presents substantial implications for educational practices. As AI technology evolves, it is essential to consider strategies for its effective incorporation in educational settings without compromising pedagogical integrity. Enhancing AI's contextual understanding is one avenue that holds promise for educational applications; tailored AI responses could improve students' ability to align UDA design elements with nuanced educational objectives. This advancement would likely require ongoing collaboration between AI developers and educators to refine algorithms that account for varied educational scenarios and learning environments.

Additionally, future training programs for educators should focus on equipping them to use AI tools as enhancements to, rather than replacements for, their instructional expertise. Approximately 85% of students expressed interest in continuing to use ChatGPT as a supplementary resource, emphasizing the need for educators to guide students on how to critically engage with AI-generated content. Encouraging reflective practices—where students assess AI's contributions in light of their instructional goals—will help maintain a balance between technological assistance and critical pedagogical thinking (Fig. 13). These practices will be crucial in ensuring that AI serves as a constructive tool that enhances, rather than undermines, educators' role in shaping students' learning experiences.

Ethical considerations must also be addressed as institutions increasingly adopt AI technologies. Concerns surrounding data privacy and algorithmic bias are particularly salient in educational settings, where trust between students and educators is paramount. Institutions should establish transparent guidelines regarding the handling of data and the functionality of AI tools, fostering a secure and trusted educational environment.

The integration of ChatGPT alongside the CONALI framework demonstrates considerable promise for enriching the instructional design process. The observed benefits—such as increased understanding of task requirements, improved efficiency, and high student satisfaction—highlight the potential for these tools to support the creation of well-structured and innovative UDAs. However, as demonstrated by the challenges related to critical thinking, technical limitations, and the risk of AI dependency, it is essential to navigate AI integration with caution.

As AI technologies continue to shape educational practices, it is imperative that educators approach these innovations thoughtfully, prioritizing both ethical use and pedagogical depth. By fostering an

environment where AI serves as a supportive, rather than a replacement, tool, educators can prepare future generations to navigate an increasingly complex educational landscape. These findings advocate for a balanced, critically engaged approach to AI in education, one that respects the insights of human educators while embracing the efficiencies AI offers.

The ongoing dialogue surrounding AI's role in education will undoubtedly influence instructional design and teaching strategies in the years to come.

5. Conclusion

The integration of artificial intelligence (AI) tools such as ChatGPT, in conjunction with the Constructive Alignment Ontology (CONALI), represents a significant innovation in instructional design for primary education science students. This concluding analysis synthesizes the findings from the results and discussion, highlighting the dual potential of these tools to support instructional clarity and creativity while raising crucial considerations for their responsible integration in educational practice.

5.1. Future implications for educational practice

The data reveals a positive reception among students towards combining ChatGPT with the CONALI framework, underscoring the potential of these tools to facilitate effective instructional design. Specifically, 90% of students reported an enhanced understanding of learning objectives, and attributed this improvement to ChatGPT's capability to clarify task requirements. By supporting the alignment of learning outcomes with appropriate teaching strategies, ChatGPT demonstrated its utility as a complementary resource, aligning well with Constructive Alignment (CA) principles to enhance instructional coherence. Moreover, the satisfaction rate of 85% among students in using ChatGPT further underscores its positive impact on their UDA design experience. The efficiency gains associated with AI were particularly noteworthy; a substantial number of students completed their designs faster than anticipated due to ChatGPT's support in generating objectives and organizing ideas. Approximately 75% of participants acknowledged ChatGPT's role in streamlining the ideation process, allowing them to prioritize quality and depth rather than getting stalled in initial brainstorming phases (Fig. 8). This finding reinforces the importance of integrating AI as a strategic support mechanism in education, particularly where time constraints are a factor. However, alongside these benefits, the study revealed specific challenges that warrant careful consideration. A significant portion of students (70%) emphasized the necessity of applying critical judgment when working with AI-generated content. While ChatGPT provided a foundation for ideas, students noted that personal insight remained essential to ensuring relevance and pedagogical accuracy, highlighting the need for critical thinking skills in educational technology use (Fig. 11). Moreover, technical issues such as limited server availability and delayed responses with the free ChatGPT version detracted from the user experience, underscoring the importance of reliable, accessible tools in educational settings (Fig. 12). These limitations suggest that while AI is a valuable asset, it is not without its constraints and requires integration with deliberate oversight.

5.2. Implications for educational practice

These findings suggest several key implications for the use of AI and structured frameworks like CONALI in instructional design. First, educators must guide students on how to effectively engage with AI-generated content without compromising their analytical capabilities. Training programs should place a strong emphasis on critical evaluation, encouraging students to critically assess AI inputs to cultivate pedagogical judgment. Reflective practices, where students are prompted to consider the AI's outputs within their instructional context, will be fundamental to ensuring robust instructional competencies.

To maximize the contextual relevance of AI-generated suggestions, further advancements in AI's understanding capabilities are essential. The development of algorithms that better account for diverse educational contexts could provide more tailored responses, directly addressing specific instructional needs. Collaboration between educators and AI developers could facilitate these improvements, ultimately creating a more adaptable AI resource suited to varied pedagogical scenarios.

Ethical considerations are also paramount, particularly as AI becomes more integrated into educational settings. Transparency in AI's data handling and algorithmic functions will be essential for fostering trust among educators and students. Institutions should proactively establish clear ethical guidelines for AI use, including data privacy measures and policies for mitigating algorithmic bias. These protocols will support responsible AI integration and reinforce the credibility of educational technology in institutional practices.

Additionally, while AI can serve as a powerful aid in UDA design, it is essential that it not replace traditional instructional methods or human insight. Educators remain central to guiding students through the intricacies of instructional design, and their role in fostering critical thinking skills is irreplaceable. By positioning AI as an enhancement to traditional pedagogical strategies, educators can ensure that students receive a balanced approach, benefiting from technological support while developing their independent analytical skills.

5.3. Future directions

Looking forward, further research is necessary to explore the long-term effects of integrating AI tools like ChatGPT into teacher education programs. Longitudinal studies could provide insights into how sustained AI use shapes pedagogical skills over time, and whether it leads to improved educational outcomes among future educators. Additionally, examining how AI influences student perceptions and experiences with technology in education can inform best practices for effective AI integration. Qualitative methods, such as interviews or focus groups, could offer deeper insights into how students perceive and utilize AI, shaping a more nuanced understanding of its role in instructional design.

In conclusion, the combination of ChatGPT and the CONALI framework presents a valuable enhancement for instructional design among primary education science students, promoting improved clarity, efficiency, and satisfaction in the UDA design process. However, challenges such as fostering critical thinking, addressing technical limitations, and preventing over-reliance on AI must be navigated with care. As technological advancements continue to reshape educational practices, it is imperative that educators approach these tools thoughtfully and ethically, fostering an environment where AI serves as a supportive tool that complements, rather than replaces, human expertise.

By cultivating a balanced approach that embraces AI's efficiencies while prioritizing critical engagement, educators can effectively prepare future teachers for an increasingly complex educational landscape. The ongoing dialogue surrounding AI's role in education will undoubtedly shape the trajectory of instructional design, setting the stage for thoughtful and effective technology integration in the years to come.

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