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AI Tools for LSP and Education

Can AI Force Traditional ELT Publications out of Their Comfort Zone?

Adrian Ciupe

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Traditional ELT publications such as learners' dictionaries and vocabulary development books have long been regarded as definitive resources for learners of English. Nonetheless, the advent of AI platforms and services like ChatGPT has introduced a new reference framework, one likely to challenge the existing *status quo*. Traditional ELT publications increasingly appear dated, incomplete or even abandoned projects, shaped by macrofragmentation (via rigid taxonomies) and microfragmentation (through subjective and often inconsistent inclusion or omission), resulting in fragmented learning. This paper seeks to explore whether AI tools like ChatGPT can build on or even replace traditional publications by offering a more dynamic, holistic and inclusive approach to language learning.

AI; ChatGPT; ELT; fragmentation; holism.

1. Introduction, premises and disclaimers

Until recently – a couple of years ago – prestigious publishers like Oxford, Cambridge, Longman (Pearson), Macmillan, or Collins (COBUILD) used to be considered the last word in ELT publications. From grammar to vocabulary and covering the entire language level range, from A1 to C2, these publishers have relied heavily (perhaps also to legitimise their marketing strategies) on the authority of in-house corpora to power their end products – examples of such corpora include the Cambridge International Corpus, the Collins Corpus, the Oxford English Corpus, the Longman Corpus Network, etc. Towards the end of 2022, ChatGPT (OpenAI, n.d.) came along and started – perhaps unwittingly – to challenge the entire ELT materials publishing industry, not only thanks to the sheer size of the LLMs at its disposal, but also by providing something that the aforementioned publishers could not: a tool at any language teacher's / learner's disposal, capable of upending the traditional paradigm of *language authority → final product*. This new context signals a paradigm shift towards *language user → final product*. In other words, AI services like ChatGPT can contribute to the *democratisation* of language learning materials

development and use – but this carries a logical caveat: traditional ELT publications are finished products provided by established, traditional publishers *as such*, whereas ChatGPT (or any similar AI service) is a tool, not a product (or a finished product in itself, for that matter).

This article seeks to explore this possible paradigm shift: from ELT end products from traditional publishers to ELT product creation by language teachers or learners themselves through the use of AI tools. The whole logic of this article is based on three main premises (or disclaimers):

(1) As the author of this article, I automatically benefit from a double status. I am not only a teacher of English, but being a non-native speaker of English, I could be considered a lifelong learner of English as well – this is what, for purely logical reasons, native-speaking teachers of English do not possess in terms of language acquisition experience, nor perspective.

(2) The scope of this article cannot possibly allow for an exhaustive look at ELT within the traditional paradigm and the new one I am mentioning here. Drawing on the Lexical Approach, I will be focusing on what has been traditionally treated as *vocabulary* teaching and learning. In summary, the Lexical Approach posits that vocabulary cannot be *divorced from* grammar or *vice versa* (Hill, 2000, p. 65); language needs to be looked at holistically, in terms of *grammaticalised lexis* and not *lexicalised grammar* (Lewis, 2000a, p. 137). *Language chunks* (i.e. collocation + colligation) are intrinsic to language learning and acquisition, based on repeated exposure to language contexts (i.e. recurrent language chunks) (Lewis, 2000b, p. 198). Within this framework, *unedited examples of usage* (containing language chunks) are crucial for language acquisition, in that they provide actual instances of language use in context (Woolard, 2000, p. 35), where grammar and vocabulary merge naturally and organically.

(3) Like any other novelty, AI services such as ChatGPT have given rise to some concerns. In this particular case, (a) that language teachers will be replaced by AI – this is nothing but nonsensical. Language teachers *cannot* be replaced by AI for the simple reason that language teachers will always be *the necessary interface between* their students and AI: teachers can use AI to design and streamline their courses and students can benefit from guidance in using AI on their own, based on prompt engineering, in its turn, facilitated by teachers through adequate training. The second case (b) regards using AI for fraudulent purposes (i.e. students delivering assignments or sitting language exams) – this issue, although not covered in this article, deserves separate treatment (perhaps another article); while this can be a challenge (and not just in the case of language instruction), it all comes down to a simple fact: using AI *is not about using an end product, but a tool*! The tool itself *cannot be blamed for its mere potentiality* – the use of it, yes, but again, this deserves a separate discussion, not present here.

2. Traditional ELT publications today: timelines and accessibility

Following from the above delineation, by *traditional ELT publications* I mean learner's dictionaries and vocabulary development books or resources produced by major publishers in the field, such as Oxford, Cambridge, Longman (Pearson), Collins / COBUILD and Macmillan. For the sake of my argument, first, I will be providing a list of such products below – special attention should be paid to the release year for each one – and then I will be discussing some problems or shortcomings that have become apparent, all referring to very practical considerations as regards their consistency, usability and usefulness at the present time.

To keep these lists as concise as possible, I will be quoting *only* such publications at an *advanced* level. They are all numbered continuously and, for simplicity, I will be making reference to them later, based on their identifying numbers below.

Starting with learner's dictionaries, from Oxford University Press:

(1) *Oxford advanced learner's dictionary*, 10th ed. (2020); book + free online + app;
(2) *Oxford collocations dictionary for students of English* (2009>2021); book + app;
(3) *Oxford learner's thesaurus – a dictionary of synonyms* (2008>2021); book + app;
(4) *Oxford phrasal verbs dictionary for learners of English*, 2nd ed. (2006); book;
(5) *Oxford idioms dictionary for learners of English*, 2nd ed. (2006); book.

From Cambridge University Press:

(6) *Cambridge learner's dictionary*, 4th ed. (2012); book + free online + app;
(7) *Cambridge idioms dictionary*, 2nd ed. (2006); book;
(8) *Cambridge phrasal verbs dictionary*, 2nd ed. (2006); book.

From Macmillan:

(9) *Macmillan English dictionary for advanced learners*, 2nd ed. (2007); book;
(10) *Macmillan collocations dictionary for learners of English* (2010); book;
(11) *Macmillan phrasal verbs plus* (2005); book;
(12) *The Macmillan dictionary of English colloquial idioms* (1995); book.

From Longman (Pearson):

(13) *Longman dictionary of contemporary English*, 6th ed. (2014); book + free online + app;
(14) *Longman collocations dictionary and thesaurus* (2013); book;
(15) *Longman phrasal verbs dictionary* (2000); book;
(16) *Longman idioms dictionary* (1998>2000); book.

From Collins / COBUILD:

(17) *Collins / COBUILD advanced learner's dictionary*, 10th ed. (2023); book + free online;
(18) *Collins / COBUILD phrasal verbs dictionary*, 4th ed. (2020); book;
(19) *Collins / COBUILD idioms dictionary*, 4th ed. (2020); book.

As for vocabulary development / practice books, for the sake of illustration, I would consider just one *complete* set (again, at an advanced level), such as the *in use* suite from Cambridge University Press (the numbering above continues below):

(20) *English vocabulary in use, advanced*, 3rd ed. (2007>2017); book + e-book;
(21) *English collocations in use, advanced*, 2nd ed. (2008>2017); book;
(22) *English idioms in use, advanced*, 2nd ed. (2010>2017); book;
(23) *English phrasal verbs in use, advanced*, 2nd ed. (2007>2017); book.

The first problem I would mention, which is also self-evident, concerns the years of release. At a glance (the numbers above are reference numbers),

(a) published until 2000: (12), (15) and (16);
(b) published in the mid 2000s: (4), (5), (7), (8), (9) and (11);
(c) published in the early and mid 2010s: (6), (10), (13) and (14);
(d) published in the early and mid 2020s: (1), (17), (18) and (19).

In the case of (2), (3), (20), (21), (22) and (23), the first year in brackets refers to the first release (or edition) and the second, while indicating the *latest* edition, is in actual fact more of a reprint than a new edition – the original content is largely the same but presented in a different layout (or format, in the case of the app equivalents). Based on the release years specified above, quite a lot of these publications appear to be either discontinued / out of print or, simply, abandoned. The obvious question is *Why?* While the vagaries of marketing strategies might have come into play over the years to justify this *abandonment* or, at least, stagnation, this problem *does* point to a certain kind of *fracture* in consistency – add to this the fact that one of the publishers mentioned (Macmillan) discontinued its line of dictionaries altogether and in any format (book, online, app).

Another self-evident aspect that may be considered problematic now in 2025 is that of the *format* or *accessibility*, especially in the case of dictionaries. (7) and (8) above used to be complemented by mobile app formats (now discontinued / no longer available, at least on Android); (4), (5), (10), (11), (12), (15), (16), (18) and (19) have always been solely available in book formats, which makes consulting them extremely slow and laborious – strangely enough, although released in the early 2020s, (18) and (19) are still just books, without any digital counterparts (online / apps), seriously detracting from their usefulness, regardless of content quality. Special mention should be made about (9) and (14): (9) is accompanied by a CD-ROM counterpart, which is now totally unusable, given its

incompatibility with newer computer operating systems (e.g. Windows 10 / 11), not to mention / reiterate the fact that even its free online version is now defunct. As to (14), it originally came with free two-year access to its dedicated online counterpart, now no longer available (discontinued).

If this section has looked at more physically tangible features of traditional ELT publications in terms of *release timelines*, *availability* and *accessibility* based on their formats, the next one will go deeper, by analysing the conceptual framework behind their content, applicability and relevance to learning and teaching needs at this point in time.

3. Traditional ELT publications: fragmentation

Regardless of the publisher, most – if not all of them – follow the same product release pattern. In the case of learner's dictionaries: a general dictionary (all publishers) + a collocations dictionary (some publishers) + a thesaurus (some publishers) + a phrasal verbs dictionary (all publishers) + an idioms dictionary (all publishers). Regarding vocabulary development books / resources, a *complete* suite would be the pattern adopted by Cambridge University Press, with its *in use* series (cf. the previous section): a book for general vocabulary, one for collocations, one for idioms and one for phrasal verbs – the content of each being structured by topic.

While the above patterns can seem logical in conception and purpose, they reflect a traditionally analytical way of thinking: A + B + C etc. = TOTAL *relevant* content / knowledge to be mastered by learners. In other words, I would call this *macrofragmentation* or *fragmentation by taxonomy* (*general vocabulary* + *collocations* + *phrasal verbs* + *idioms*). For a better understanding of the problems this could engender for language learners, as a teacher, imagine that a student approaches you with a question like: *I want to be able to reach and master an advanced level of English. Could you tell me what / how many books (or resources) I should get and what kind?* A *logical* answer to this kind of question from a student might be: *Well, let's see… You will surely need a good general dictionary, but given its space limitations, you would also need some specialised ones that can offer more details on collocations, phrasal verbs, idioms and synonyms. Besides, to practise all these, you should also get some vocabulary development books (separately) focused on each of these problems…* Any (teacher's) answer to such a (student's) question would certainly be quite complicated to offer and likely not only to confuse students but also dishearten them through the sheer effort and volume of work implied. This kind of *fragmentation by taxonomy* is likely to fracture the learning process (and ultimately the acquisition of language) for the simple reason that in this way, a student's approach, understanding and learning in general will become *fragmented* – thus, *not free-flowing or organic*; students may (falsely) have the impression that each distinct problem (vocabulary / collocation / idiom / phrasal verb) is disconnected from (or irrelevant

to) any of the others, consequently adopting a *fractured* or *fragmented* approach and attitude to learning, e.g. *Now that I've done some practice on collocations, I'll do some on phrasal verbs – and after that, on idioms etc.* This is exactly what traditional ELT dictionaries and vocabulary development publications have encouraged so far, slowing down learning progress by focusing too much on analytical taxonomies instead of on an integrative and holistic framework.

Possible solutions to the above problem could be provided in a twofold manner (*content* + *accessibility*): by merging all different types of learner's dictionary into a single one featuring all relevant target language items (words, collocations, idioms, phrasal verbs, synonyms etc.) – of course, due to the sheer volume of the content involved, *accessibility* should be through *electronic formats* (online or apps) rather than books; by merging all different types of vocabulary development books into a single one as well, with all relevant target language items unified under *one single taxonomic label*: *language chunk* – students will have been briefly trained beforehand in distinguishing between *fixed phraseology* (idioms, phrasal verbs, prepositional phrases) and *semifixed expressions* (collocations) but for the practice itself by using such books and resources, having in mind the concept of *language chunk* should suffice, this facilitating a smoother and more organic experience, uninterrupted (*not fragmented* / *fractured*) by being constantly reminded of separate taxonomic labels.

Macrofragmentation, or *fragmentation by taxonomy* as described above, also inevitably leads to *microfragmentation*, or *fragmentation by omission* – the latter is to be found at sentence level and refers to highlighting different words or expressions in an example sentence in order to draw attention to them as targeted language items (e.g. single words, collocations, phrasal verbs, idioms etc.). While apparently useful for students, singling out such language items through highlighting ignores (i.e. omits) other relevant language items in the same sentence, which are not highlighted. Besides, the targeted (highlighted) language items are usually *artificially separated* from the larger (relevant) context within the same example sentence, making students see them *analytically*, as *taxonomic labels* to the detriment of the rest of the (relevant) language in one particular example sentence – this is why a single label, such as *language chunk*, would be much more helpful to be aware of; a *language chunk* is not only, for example, a binary construction (e.g. verb + particle or word 1 + word 2 in a collocation etc.) but more importantly, a larger, more natural and integrative context, where *collocation and colligation merge*. For a better understanding of *microfragmentation* (*by omission*), let us consider some example sentences from vocabulary development books. Example sentence (A) contains the author's original highlighting of a certain targeted language item; example sentence (B) also accounts for the relevant language omitted in the original version (A) (example sentence (B) offers *my own* suggestion for highlighting).

Example 1 (McCarthy et. al., 2002, p.32) – targeted language: general vocabulary about work routines:
(A) *She works fixed hours; she has a* ***nine-to-five job****.*
(B) *She* ***works fixed hours****; she* ***has a nine-to-five job****.*

Example 2 (O'Dell et. al., 2017a, p. 26) – targeted language: collocations related to working life:
(A) *I had managed to build up a* ***network of contacts*** *and this gave me a good start.*
(B) *I had managed to* ***build up a network of contacts*** *and this* ***gave me a good start****.*

Example 3 (McCarthy et. al., 2017, p. 66) – targeted language: phrasal verbs related to work:
(A) *We have to keep talking constructively and try not to get* ***bogged down*** *in lengthy negotiations which only prolong the strike.*
(B) *We have to* ***keep talking constructively*** *and try not to* ***get bogged down in lengthy negotiations*** *which only* ***prolong the strike****.*

Example 4 (O'Dell et. al., 2017b, p. 62) – targeted language: idioms related to work:
(A) *She got a very generous* ***golden hello*** *when she started her first job after university.*
(B) *She* ***got a very generous golden hello*** *when she* ***started her first job after university****.*

As can be seen above, the original author's choice – the (A) example versions – of which items to highlight, certainly guided by the best intentions in trying to signal a taxonomic item, results in the *omission* of other relevant language present in the same sentence and / or in *removing* that particular highlighted item from its natural context (*language chunk*) by severing its colligational ties. This *microfragmentation* (*by omission*) ends up defeating the purpose of language exposure and *intake* by hampering further *encoding*, given that learners are distracted from a more integrative language context (*language chunk*) for the sake of being made aware of an *isolated* language item.

The last type of fragmentation I would like to discuss here is that by *topic tagging* (or *subjective choice* of language items). Most vocabulary development books (including those focused on taxonomic categories like collocations, idioms and phrasal verbs) are structured by topic. While at first sight this method would seem helpful, two problems arise.

The first problem concerns the *scope* of the language covered in each topic-based unit of such a book. A typical book unit presents and practises around 15–20 language items *connected to a specified* topic. Due to obvious space constraints, the author's choice

of which items to include and which ones to leave out becomes obviously *subjective*, let alone *impressionistic*. For example, in *English phrasal verbs in use, advanced*, the topic unit entitled *Business* (McCarthy et. al., 2017, p. 74) features two small (even tiny) subsections: *(A) Structuring a business* – with only 5 language items (phrasal verbs) covered and *(B) Doing business*, which includes 9 such items; thus, a total of 14 items in this entire unit. While space constraints are understandable, the danger posed by too much generalisation and heavily trimming down the volume of language presented (and practised) is that learners may be left with the wrong impression that in order to talk effectively about e.g. *structuring a business*, 5 phrasal verbs are enough and, respectively, for *doing business*, 9 would suffice. In other words, the author's *authority* behind their (necessarily) subjective choice dictated by space limitations will be reflected in learners' choices later on.

The second problem posed by this type of *fragmentation* refers to the relevance of the language covered. By way of illustration, let us consider a few instances of input language (example sentences) taken from some of the *in use* suite of books from Cambridge University Press – the example sentences below include the author's original highlighting of the language items covered / presented / exemplified (incidentally, in some cases this also provides further illustration of *microfragmentation*).

> Example 1 (O'Dell et. al., 2017b, p. 88) – targeted language: idioms for advising and warning:
> *My advice to you is to* ***reach for the stars****.*
> Comment: This example sentence is featured in the unit called *Advising and warning*; however, the only language that explicitly refers to advice is *not* the targeted idiom (***reach for the stars***), which could be used in a lot of other situations, not necessarily connected to the topic *advice*, but simply, *my advice to you is…* (which is not an idiom).
>
> Example 2 (same book, same unit):
> *It's time to* ***turn over a new leaf*** *and start behaving responsibly.*
> Comment: Again, the targeted idiom itself (***turn over a new leaf***) is *not* intrinsically linked to giving advice but the language not targeted as such (*it's time to…*) is.
>
> Example 3 (O'Dell et. al., 2017a, p. 56) – targeted language: collocations about travel and adventure:
> *I could hardly* ***contain my excitement*** *when I set off for South America…*
> Comment: The highlighted collocation ***contain my excitement*** does *not* necessarily refer to the topic *travel and adventure*, whereas the phrasal verb construction *set off for South America* (not highlighted) does!

Example 4 (same book, same unit):
*The women have **faced severe weather conditions** since setting off to walk to the North Pole…*
Comment: Once again, the highlighted collocation ***faced severe weather conditions*** is more related to the topic *weather* rather than *travel and adventure*, whereas *setting off to walk to the North Pole* (not highlighted) does refer to the topic in question.

Example 5 (same book, same unit):
*… they had been relieved to report the weather was sunny and **their spirits were high**.*
Comment: Like in the preceding examples, the highlighted language item does *not* directly refer to the topic announced in the title of that respective unit.

Examples like these abound in vocabulary development books like those belonging to the *in use* suite from CUP. It becomes evident that *fragmentation by topic tagging* or *subjective choice of language items* is based on *impressionistic assignment of topic tags* to language items not necessarily directly linked to the purported theme or topic. This is further compounded by space constraints (understandable when it comes to *book* formats) that limit the number of targeted language items covered in one particular topic-tagged book unit. All these are highly likely to confuse learners and misdirect them in their language acquisition endeavours despite the best of intentions behind such learning resources.

4. The promise of AI

As shown in the second section of this article, the vast majority of *traditional* ELT books and resources were released in the mid 2010s – if that were to be considered their heyday, one could not help wondering *why the huge gap between the mid 2010s and 2022 (almost a decade) when AI services like ChatGPT became publicly available?* This substantial time gap demonstrates that the stagnation of traditional ELT publications has *not* been caused by the advent of AI. Stagnation through abandonment and lack of innovation on the part of the major ELT publishers may also testify to a plateau reached naturally: this is pretty much all that could have been achieved based on the traditional mindsets that have been the norm in ELT publishing for decades. So, how about the new age of artificial intelligence regarding ELT? Where and how do / can AI services like ChatGPT come into play?

As mentioned among the premises of this article, right from the outset, no confusion should be made between traditional ELT publications and AI – they cannot be compared

to one another since they are different entities: the former are already finished products existing as such while the latter is a tool possibly conducive to other (kinds of) finished products related / relevant to ELT. For clarity and ease of reference, from now on I will be referring to ChatGPT as the prime example of AI service for further arguments in this article.

As a tool, ChatGPT is completely dependent on how effectively it is used – from an ELT standpoint, by teachers and learners alike. This effectiveness rests on users' competence in crafting prompts that are likely to yield the best possible results – the end products achieved in the process will reflect exactly this kind of *competence*. In what follows, I will provide a few examples of ChatGPT-generated material that can address the shortcomings of the traditional ELT products mentioned in this article.

First, the problem of single items, i.e. *language chunks*. I have already made the case for larger contexts, where collocation and colligation are taken as a whole, thus making the need to refer to distinct taxonomic categories (collocation, phrasal verb, idiom, prepositional phrase) irrelevant or inapplicable. While it may apparently be helpful for learners to *know what's what* in terms of such taxonomies, insisting too much on them can obstruct or fracture understanding, decoding, intake and encoding afterwards. Making use of the generic term *language chunk* (instead of collocation, idiom, phrasal verb etc.) can confer much more freedom and relevance as regards learners' efforts – what counts more: to make learners analytically aware of the theoretical / technical concepts behind language use, or to make them more capable of sounding *fluent* and *natural* in the use of language by facilitating *encoding* (language *output*) itself? Here are two examples.

> Example 1: Without explicitly asking ChatGPT to provide a definition and usage examples for the *phrasal verb to get bogged down in something*, I simply asked for these by just providing ChatGPT with the language chunk *(get) bogged down in…*. Here is what ChatGPT offered:
>
> *get bogged down in… (to become so involved in details, problems or a particular task that progress is delayed or halted):*
>
> *Try not to get bogged down in **minor issues** and focus on the bigger picture.*
> *We got bogged down in **endless paperwork** and couldn't move the project forward.*
> *She tends to get bogged down in **overanalysing things** rather than taking action.*
> *Let's not get bogged down in **technicalities** — just explain the main idea.*
> *The team got bogged down in **meetings** that achieved very little.*
> *He often gets bogged down in **perfectionism** and misses deadlines.*
> *I don't want to get bogged down in **this argument** — let's just agree to disagree.*
> *They got bogged down in **bureaucratic red tape** and couldn't open the shop on time.*

*We were bogged down in **so many details** that we forgot our initial goal.*

The number of example sentences could obviously continue – what is important is that ChatGPT can offer *both* a very clear definition of a specific language item *and also* a large number of example sentences to illustrate typical usage (in the above example sentences I highlighted the collocates of *be / get bogged in…* in testimony to this), thus providing what traditional dictionaries *cannot*, due to space constraints. To keep this article section succinct, I will not be discussing here the vast array of teaching / learning activities that can be derived from such a list of examples; I would only draw attention to the wealth of useful language in each sentence – e.g. in the first sentence, learners see not only a chunk containing the targeted item (*get bogged down in minor issues*) but also another chunk worth paying attention to: *focus on the bigger picture*; in the second example sentence, not only *got bogged down in endless paperwork* but also *couldn't move the project forward* and so forth – in other words, by drawing attention to all the language chunks in one particular example sentence, not only that / those containing targeted items, the problem of *microfragmentation* disappears (see previous section).

Example 2: Starting from the fact that for the idiom *to trim your sails OALD 10* only offers the brief definition *to reduce your costs*, without any usage example sentence at all, I asked ChatGPT for a clearer definition and several example sentences for the language chunk *trim their sails* (this being the exact form – cf. *colligation* – in which I had encountered it in context). Here is what ChatGPT came up with:

trim their sails (to reduce one's ambitions, spending or activities in response to changing conditions or limitations, often financial or strategic):

*With the downturn in the economy, **many companies had to** trim their sails just to stay afloat.*
***The council was forced to** trim its sails after government funding was slashed.*
*When the budget was cut in half, **the project team had no choice but to** trim their sails.*
*He had big plans for the business, but **once reality hit, he had to** trim his sails.*
***Many households have been forced to** trim their sails in the face of rising living costs.*
***After a few bad investments, she had to** trim her sails and rethink her retirement plans.*
***We'll need to** trim our sails this year if we want to avoid going into the red.*

Again, in order to make the most of the ChatGPT response, I would draw attention to relevant collocations / colligations (see the highlighted chunks) that can be used together with the idiom itself; more than that, just like in the first example, more relevant language chunks are present in such example sentences, *not only the targeted item*; e.g. in the first

sentence, *the downturn in the economy*, *stay afloat*; in the second sentence, *government funding was slashed*; in the third sentence, *the budget was cut in half* etc.

Example 3: We have already seen that topic coverage in traditional vocabulary development books is hampered by space limitations as well as by *macrofragmentation* (i.e. dealing with different taxonomic categories of language items in different books – an artificial separation or fragmentation of vocabulary material). ChatGPT may offer a solution in that space limitations are no longer a problem and vocabulary is treated synthetically and holistically, *as a collection of language chunks*, rather than analytically, based on taxonomic labels. Here is a ChatGPT-generated example referring to the topic *BUSINESS*, focused on the subtopic *COMPETITION AND COMPETITORS* (in order to keep this example concise, I have included only 20 language chunks – they may illustrate idioms, phrasal verbs, collocations, prepositional phrases etc.; obviously, ChatGPT can generate an indefinite number of such examples of language chunks and their typical usage):

face stiff competition *(encounter strong rivals in the market)*
We ***face stiff competition*** *from larger firms offering similar services.*

stay ahead of the competition *(maintain a lead over rival businesses)*
We're investing in new technology to ***stay ahead of the competition****.*

undercut the competition *(offer lower prices than rivals)*
They managed to ***undercut the competition*** *by sourcing cheaper materials.*

outperform rivals *(do better than competing businesses)*
Our online sales have ***outperformed rivals*** *for the third quarter in a row.*

gain a competitive edge *(achieve an advantage over others)*
Offering next-day delivery gave us ***a competitive edge****.*

a saturated market *(a market with too many similar products or services)*
It's hard to stand out in ***a saturated market*** *like mobile phone accessories.*

a fierce competitor *(a very strong and aggressive rival)*
They've become ***a fierce competitor*** *in the online fashion space.*

monitor the competition *(observe and analyse what competitors are doing)*
We regularly ***monitor the competition*** *to adapt our strategy.*

a crowded marketplace *(a business environment with many players)*
With so many apps available, it's ***a crowded marketplace****.*

gain market share *(increase the percentage of sales in a market)*
They launched an aggressive campaign to ***gain market share****.*

keep up with the competition *(maintain pace with rival businesses)*
We need to innovate if we want to ***keep up with the competition****.*

an emerging competitor *(a new business starting to challenge established players)*
There's ***an emerging competitor*** *that's gaining popularity with young customers.*

edge out the competition *(slightly surpass rivals)*
Their latest ad campaign helped them ***edge out the competition*** *last month.*

take on established players *(challenge well-known, long-standing businesses)*
We're ready to ***take on established players*** *in the home delivery market.*

outmanoeuvre competitors *(gain an advantage by acting more cleverly)*
They managed to ***outmanoeuvre competitors*** *by securing early access to the tech.*

carve out a niche *(create a distinct position within a competitive market)*
We've ***carved out a niche*** *by focusing on sustainable materials.*

a key rival *(an important or primary competitor)*
Tesco remains ***a key rival*** *for any new supermarket chain in the UK.*

cut-throat competition *(very aggressive or ruthless rivalry)*
The travel industry has become ***cut-throat competition****, especially online.*

go head-to-head with someone *(compete directly)*
We're about to ***go head-to-head with*** *our biggest rival in the streaming sector.*

dominate the market *(be the most powerful player in a particular industry)*
They continue to ***dominate the market*** *in contactless payments.*

Incidentally, see how the above example sentences also include language chunks, other than the targeted / highlighted ones, which are relevant to the same (sub)topic, e.g. *larger firms offering similar services*, *investing in new technology*, *sourcing cheaper*

materials, *... for the third quarter in a row*, *offering next-day delivery*, *mobile phone accessories*, *the online fashion space* etc. Additionally, using ChatGPT for this kind of purpose allows for *highly customised / detailed subtopics*. In effect, instead of using a prompt requesting generic vocabulary for the topic *BUSINESS*, teachers and learners could use very specific ones, based on their needs, featuring subtopics like: *BARELY SURVIVING OR STAYING AFLOAT, BEING COMPETENT AND SUCCESSFUL, BEING DISHONEST IN BUSINESS, BEING HONEST IN BUSINESS, BEING INCOMPETENT AND UNSUCCESSFUL, BEING SUCCESSFUL OR VERY SUCCESSFUL, BREAKING INTO NEW MARKETS, BRANCHING OUT, COMPETITION AND COMPETITORS, CONDUCTING BUSINESS IN GENERAL, DOWNSCALING, FIRING EMPLOYEES, FREELANCING AND FREELANCERS, HIRING STAFF, LAYING OFF STAFF, MAKING LOSSES, MAKING PROFIT, LEADERSHIP STRUCTURE, INTERNAL RESHUFFLING, RESTRUCTURING, MERGERS, TAKEOVERS, ACQUISITIONS, ON THE BRINK OF BANKRUPTCY, GOING BANKRUPT, PARTNERSHIPS AND PARTNERS, PROFITABLE OR VERY PROFITABLE, SELLING A LOT, SELLING YOUR BUSINESS OR CLOSING DOWN, STARTING YOUR OWN BUSINESS, UNPROFITABLE OR VERY UNPROFITABLE, NOT SELLING MUCH, UPSCALING, WHEN BUSINESS IS BRISK, WHEN BUSINESS IS SLOW* etc.

Example 4: Language functions (i.e. *what to say / how to say something in situation X*) have traditionally been only barely covered in ELT preparation books – usually, these are featured in minimal lists, either preceding a *speaking* or *writing* task or at the end of the respective book, as an appendix (e.g. *language bank*). However, a well thought out ChatGPT prompt could yield much more substantial and relevant instances of usage (in this example, referring to the main function *PRESENTATIONS*, particularly the subfunction *FINISHING UP, THANKING AND GREETING – INFORMAL TONE*); again, for the sake of brevity, I include only 20 entries here:

*Alright, that's **a wrap**—thanks so much for being here!*
*(**A wrap** is an informal phrase meaning the session is over.)*

*Thanks everyone—**really appreciate you sticking around**.*
*(**Really appreciate you sticking around** is a friendly way to thank people for staying until the end.)*

*Hope that all made sense—**cheers for listening**.*
*(**Cheers for listening** is an informal and typically British way of expressing thanks.)*

*That's me done—**thanks a lot for showing up**.*
*(**Thanks a lot for showing up** is a relaxed and genuine way to appreciate attendance.)*

*We're all finished here—**big thanks for being part of it**.*
*(**Big thanks for being part of it** is an informal, warm way to show gratitude.)*

*Hope you've enjoyed it—**thanks for joining in**.*
*(**Thanks for joining in** is a casual way to acknowledge both presence and participation.)*

*Alright, I'll leave it there—**thanks again for your time**.*
*(**Thanks again for your time** is polite but relaxed and suitable for informal settings.)*

*That's everything—**you've been a brilliant crowd**.*
*(**You've been a brilliant crowd** is an upbeat, informal way to thank a responsive audience.)*

*Thanks so much—**always great to have you here**.*
*(**Always great to have you here** is a warm, informal expression of appreciation.)*

*Hope it wasn't too heavy—**thanks for bearing with me**.*
*(**Thanks for bearing with me** is a casual way to thank people for their patience.)*

*And that's all from me—**catch you next time**!*
*(**Catch you next time** is an informal and friendly farewell.)*

*Really appreciate the time—**drop me a message if you want to chat more**.*
*(**Drop me a message** is a casual invitation to follow up later.)*

*Feel free to hang back for a chat—**otherwise, see you around**.*
*(**See you around** is an informal way to say goodbye without formality.)*

*Thanks again—**hope you got something useful out of it**.*
*(**Hope you got something useful out of it** is a laid-back way to express your aim for the session.)*

*That's us done for today—**go grab a cuppa, you've earned it**.*
*(**Go grab a cuppa** is a light, informal suggestion to relax after the session.)*

*Cheers for sticking with me—**you've been fab**.*
*(**You've been fab** is an informal and friendly way to compliment the audience.)*

*Alright then, **I'll let you get on with your day**.*
*(**I'll let you get on with your day** is a casual, considerate way to close.)*

*Thanks for making the time—**lovely to see you all**.*
*(**Lovely to see you all** is an informal and warm farewell phrase.)*

*Any questions later, just **give me a shout**.*
*(**Give me a shout** is an informal offer for further communication.)*

*Take care everyone—**and thanks again for coming along**.*
*(**Thanks again for coming along** is a friendly, informal way to end a session on a positive note.)*

Just like in the case of topics, *functions* can be broken down into *subfunctions* for more effective coverage and customisation. Here are some examples of subfunctions based on the function *PRESENTATIONS*: *GREETING YOUR AUDIENCE – NEUTRAL TONE, GREETING YOUR AUDIENCE – INFORMAL TONE, INTRODUCING YOURSELF – NEUTRAL TONE, INTRODUCING YOURSELF – INFORMAL TONE, GETTING STARTED – NEUTRAL TONE, GETTING STARTED – INFORMAL TONE, CHANGING THE SUBJECT – NEUTRAL TONE, CHANGING THE SUBJECT – INFORMAL TONE, INVITING AND TAKING QUESTIONS – NEUTRAL TONE, INVITING AND TAKING QUESTIONS – INFORMAL TONE, ANSWERING QUESTIONS – NEUTRAL TONE, ANSWERING QUESTIONS – INFORMAL TONE, SUMMING UP AND CONCLUDING – NEUTRAL TONE, SUMMING UP AND CONCLUDING – INFORMAL TONE, FINISHING UP, THANKING AND GREETING – NEUTRAL TONE, FINISHING UP, THANKING AND GREETING – INFORMAL TONE* etc. Once again, the *accompanying language* in the examples above (other than the highlights) is perfectly suited to the main function – and, by extrapolation, to other possible functions in similar or related communication situations, e.g. *thanks so much for being here*, *hope that all made sense*, *hope it wasn't too heavy*, *that's us done for today*, *thanks for making the time* etc.

Examples like the ones above could continue indefinitely. So, what is *the promise of AI* regarding ELT, within the scope of the argument here? No longer in its infancy, an AI service like ChatGPT has already amply demonstrated that it can be an invaluable tool for language teachers and learners alike. Here are some key points that may support this claim – AI / ChatGPT:

(a) is freely available to all (language) users;
(b) uses real-life language instead of *textbook* language;
(c) can easily adapt to any user's existing level of language proficiency;
(d) can offer highly customised, need-based responses;
(e) can greatly speed up and diversify language learning / teaching processes;
(f) can offer large amounts of suitable learning and teaching material;
(g) encourages learner independence;
(h) encourages teaching freedom;
(i) can easily contextualise discrete language items and also unify them into a natural-sounding whole;
(j) democratises access to language resources (cf. the closed system of ELT publishers' proprietary / in-house corpora only accessible to their authors);
etc.

Ultimately – echoing one of the main tenets of the Lexical Approach, i.e. *teachers should become learning managers* (Woolard, 2000, p. 46) – AI / ChatGPT can empower both learners and teachers through a paradigm shift: rather than *purveyors of knowledge*, teachers can become *managers of learning* by training their students to craft adept prompts towards their independence in learning and acquiring language – within this new paradigm, being able to use AI tools effectively is likely to become *an essential educational competence* in the near future.

5. Conclusions

This article has argued that the emergence of AI tools such as ChatGPT represents *not merely a technological advance but a significant pedagogical opportunity within ELT*. Traditional publications – long the backbone of vocabulary instruction – are now increasingly constrained by *taxonomic fragmentation, space limitations and limited digital integration*. Their stagnation is *not* the result of AI innovation but rather a natural *plateau* reached through decades of working within fixed, analytical frameworks.

In contrast, ChatGPT functions *not* as a finished product but as a *flexible tool* that allows both teachers and learners to generate large volumes of contextualised, meaningful language input tailored to specific needs. This approach closely aligns with the Lexical Approach, which emphasises exposure to grammaticalised lexis through naturally occurring language chunks, rather than isolated, categorised items. In other words, AI helps overcome both *macrofragmentation* (by collapsing artificial / overly analytical taxonomies) and *microfragmentation* (by embedding targeted items within broader, authentic usage).

Nonetheless, realising this potential depends *not* on abandoning traditional ELT practice but on *reimagining the roles of both teacher and learner*. AI should not be seen as a threat to the teaching profession but as a means of enhancing it. Teachers can shift from *purveyors of static content* to *facilitators and managers of the learning process*, guiding students in effective AI use, including prompt design and critical reflection. Learners, in turn, become *more independent and empowered*, with AI granting them agency to explore, test and produce language in ways previously limited by the constraints of print media.

In this light, AI does *not* replace teachers or traditional resources but *reframes* them within *a more fluid, user-led and holistic paradigm*. As AI tools seem to become more embedded in educational contexts, the ability to harness their potential will emerge as *a core professional competence*. *The promise of AI* concerning ELT, therefore, lies *not* simply in speed or scale, but in its capacity to support *a more inclusive, responsive and integrated vision of language learning* – one in which traditional authority gives way to *dynamic, learner-driven exploration*.

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The Impact of AI on the Instruction and Acquisition of Foreign Languages in Higher Education

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Artificial intelligence (AI) has completely changed instructional strategies and student learning outcomes. AI technologies, such as chatbots and automated writing assistance tools, provide personalized learning experiences, enabling learners to engage in interactive tasks that enhance language acquisition. Research indicates that AI platforms significantly improve academic writing skills among language learners by offering immediate feedback on language use, thus encouraging self-regulated learning. Furthermore, educators mention that AI tools allow for dynamic assessments and support diverse learning styles in online environments. Due to the increasing implementation of AI in foreign language classes, this article presents both opportunities and challenges of using AI in education. Educators express a mixture of enthusiasm and skepticism regarding its efficacy and potential to supplement traditional teaching methods. Nonetheless, the paper considers AI as a supplementary support mechanism instead of being a total substitute for human instructors, thus enhancing rather than undermining pedagogical approaches. Overall, the applications of AI in language classrooms upgrade pedagogical strategies, facilitating more accessible and effective language acquisition in the increasingly digital landscape of education.

Artificial intelligence; language learning; benefits; challenges; applications.

1. Introduction

The recent development of Artificial Intelligence (AI) in foreign language classes marks a substantial transformation in pedagogical practices, enhancing educators' approaches to language teaching and learning. AI technologies can improve educational experiences by offering personalized learning pathways, automating administrative tasks, and facilitating interactive learning environments. As AI systems become more sophisticated, educators can tailor instruction and provide targeted support for individual students according to their needs (Nurjanah et al. 2024; Konyrova, 2024).

The potential of AI to analyze extensive datasets helps educators to discover crucial information about learners' performance and engagement, ultimately improving motivation and learning outcomes. AI systems can deliver personalized content that adapts to the pace and proficiency of each student, supporting engagement and promoting language acquisition (Konyrova, 2024). Additionally, AI-enabled platforms offer instantaneous feedback on language use, assisting students to quickly identify and correct errors—a critical component in language learning where continuous improvement is essential (Yunina, 2023).

Moreover, incorporating AI into foreign language classrooms aligns with contemporary educational trends that highlight the importance of stimulating learner autonomy and critical thinking skills. Technologies like chatbots and language learning apps can act as conversational partners, offering students the possibility of practicing speaking and listening in a low-stress environment (Liu, 2023). Through interactive learning experiences, AI tools actively engage students, encouraging them to control their learning journeys.

However, using AI in education presents some drawbacks. There's the persistent issue of equitable access—not every student has the same technical resources. Ethical concerns are another issue, especially when it comes to data privacy and the hidden biases of some AI systems (Holmes et al., 2021; Konyrova, 2024). For AI to actually make a difference in the classroom, teachers need adequate training session. When educators truly understand how to use these technologies, they will be able to enrich their instructional practices, offer more tailored support to students, and, ultimately, improve learning outcomes (Liu, 2023).

In summary, using AI in foreign language education provides transformative opportunities for enhancing language-teaching and learning experiences. Stressing the ethical and appropriate use of AI will be essential for instructors and students, in order to completely use its potential to enhance language proficiency and engagement.

2. Benefits and Challenges of Integrating AI in Teaching and Learning Foreign Languages

Artificial Intelligence (AI) in education has reshaped traditional pedagogical methodologies, particularly within the field of language learning. Regarding foreign languages, AI tools offer significant advantages that strengthen teaching and learning activities. Nevertheless, these benefits are accompanied by notable challenges that require careful consideration and strategic planning. This paper examines the dual nature of AI in foreign language education, highlighting both its promising benefits and inherent challenges.

2.1. The Benefits of AI in Language Instruction and Acquisition

The domain of language teaching and learning has been revolutionized by the use of AI tools, offering unprecedented opportunities for learners, educators, and institutions.

One of the most important benefits that AI offers in this domain is customized learning, which enhances engagement, a key element of contemporary language education. AI systems use natural language processing and machine learning to adapt to the individual needs of learners, providing tailored feedback and recommendations based on their performance (Gyawali & Mehandroo, 2022). AI tools, such as ChatGPT, have been employed to create interactive and responsive learning environments where students can receive immediate input and modify their learning strategies accordingly (Idham et al., 2024). This personalization offers students the opportunity to learn at their own pace, thus enhancing motivation and learning outcomes (Wei, 2023).

Furthermore, AI can also assist in assessment processes, helping educators to evaluate learners' progress more efficiently and accurately. For instance, AI-powered platforms can analyze language usage patterns and identify areas where students may struggle, allowing for timely interventions (Rusmiyanto et al., 2023). This is a crucial element in language learning, where the subtleties of pronunciation, grammar, and vocabulary usage require ongoing and effective feedback. The algorithms that the AI tools use provide assessments which enable students to understand their mistakes and correct them immediately (Persulessy et al., 2024).

Additionally, using AI in language learning increases engagement and interactivity. The gamification of learning experiences, enabled by AI applications, has been shown to enhance students' enthusiasm for language acquisition (Citraningtyas & Cendana, 2024). Learners today are increasingly attracted to interactive tools and games that make learning enjoyable while simultaneously challenging them intellectually. These AI-based English language games have demonstrated effectiveness in developing communication skills due to their immersive nature, which provides a safe environment for experimentation and learning (Yu & Nazir, 2021).

A benefit of AI that cannot be overlooked is the stimulation of collaborative learning experiences. AI enhances collaborative learning by connecting learners with similar proficiency levels, even in different geographical locations. Such interactions encourage social learning and increase communication skills, as students engage with their peers in meaningful language use (Li, 2022). The combination of collaboration and personalized feedback creates an entertaining and engaging learning environment where students are comfortable, reinforcing their confidence and competence.

AI technology also allows for increased accessibility to language learning resources. After COVID-19 pandemic, online learning has become more prevalent, AI tools have ensured that students remain connected to educational opportunities (Persulessy et al., 2024). Platforms that incorporate AI provide immediate access to a variety of language learning materials, from vocabulary trainers to pronunciation guides, thus breaking down traditional barriers to education that may have hampered students in less resource settings (Akbarani, 2024). The accessibility of language learning resources through AI is crucial

for promoting equity in education, allowing all students to benefit from AI and develop their skills.

Equally important is the support AI provides in higher education contexts. Research indicates that AI-driven technologies help learners develop crucial self-regulation skills by enabling them to track their development and change their approaches according to their needs (Wei, 2023). This self-regulated learning is increasingly recognized as key characteristic for current students, as it cultivates lifelong learning habits essential for personal and professional growth.

2.2. Challenges of Using AI in Foreign Languages

Although Artificial Intelligence (AI) offers numerous advantages in language learning, it has many downsides. As technology increasingly spreads in educational contexts, several significant obstacles arise that educators and learners alike must overcome to ensure its effective implementation.

One of the primary challenges is the need for substantial training and professional growth for all educators. While AI platforms can offer customized learning activities and automated feedback, educators must be adequately equipped to integrate these technologies into their pedagogical frameworks effectively. Gyawali and Mehandroo (2022) emphasize the necessity of professional development that enables teachers to fully control the capabilities of AI-based tools. Adequate training is essential to implementing AI in a manner that enriches the learning experience, otherwise technology might be underused, and it might create confusion among students.

In addition, the reliance on technology can exacerbate existing inequalities in educational access and resources. AI-based tools often require internet access and technological infrastructure that may not be readily available in all educational settings. This digital divide can hinder the equitable use of AI in foreign language learning, limiting its benefits to learners in more affluent areas while leaving those in under-resourced environments at a disadvantage (Eslit, 2023). Access disparities also extend to students' varying degrees of technological literacy, affecting their capacity to engage with AI-based resources effectively.

Another significant drawback is the possibility of over-dependence on AI systems. The automation provided by AI tools may unintentionally diminish learners' intrinsic motivation. As Ali mentions, students using AI for language learning can fall into the habit of relying too much on technology, which risks undermining their independent problem-solving skills and critical thinking capabilities (Ali, 2020). Moreover, this over-reliance can lead to a lack of engagement in traditional language practices, such as speaking and writing exercises that require human interaction and feedback. The balance between utilizing technology and engaging in authentic learning experiences is a delicate one that educators must manage carefully (Wei, 2023).

Privacy and ethical concerns represent additional challenges in the use of AI in language education. AI platforms often require extensive data collection to function optimally, a reality that raises significant questions regarding data privacy, security, and ethical usage. As Fitria (2023) discusses, these concerns can lead to anxiety among students about the safety of their personal information. The necessity for robust data protection protocols becomes critical, especially when considering the potential for misuse or unauthorized access to sensitive educational data.

Moreover, there is a challenge in ensuring the cultural context and nuances of language are effectively integrated into AI systems. Even though AI language tools can work with colossal data volumes and offer feedback, they may struggle to account for cultural differences or idiomatic expressions uniquely tied to specific English-speaking communities, for example. The absence of contextual understanding may result in learners receiving feedback that lacks depth or relevance to real-life language use, which is essential for effective communication (Vall & Araya, 2023). Understanding and interpreting the subtleties of language requires human expertise, raising questions about AI's potential to adequately replace traditional pedagogical approaches.

Lastly, variability in the effectiveness of AI tools presents an ongoing challenge. Not all AI systems perform equally well across diverse learner demographics or language proficiencies. Research indicates that the adaptability of AI systems can vary, affecting how well they meet the needs of each student (Авшенюк et al., 2024). For some learners, AI systems may reinforce language skills effectively, while for others, they may not yield the expected benefits. This inconsistency necessitates careful selection and evaluation of AI platforms to make sure they are in line with instructional goals.

3. Applications of AI in Foreign Language Writing Classes

3.1. The Use of ChatGPT into English Language Writing Classes

The integration of ChatGPT into English writing classes presents a tremendous opportunity for enhancing learners' engagement and skills. Research indicates that AI technologies like ChatGPT can significantly improve writing instruction by providing tailored feedback and suggestions according to students' needs. This dual capacity for personalization and immediate, interactive assistance aligns with pedagogical trends that prioritize learner-centered approaches, as discussed in several studies (Harunasari, 2023; Gyawali & Mehandroo, 2022).

Many researchers have highlighted the effectiveness of integrating AI into educational frameworks. We have also observed during the English writing classes that ChatGPT can enhance teaching efficacy while cultivating student motivation and engagement in language learning. Additionally, a structured approach to using ChatGPT in writing classes can facilitate higher-level cognitive engagement, enabling students to

generate ideas, structure their responses, and refine their writing (Harunasari, 2023). The introduction of AI tools supports strategic thinking in writing, reflecting a change from traditional pedagogical strategies to more inclusive and adaptive learning environments (Yunina, 2023).

Moreover, the advantages of using AI-driven platforms extend beyond individual assignments. ChatGPT can assist teachers in crafting lesson plans and educational material according to various proficiency levels within a classroom (Khan, 2023). This capability promotes a gradual, guided learning environment in which students can work at their own rhythm, thereby increasing their confidence and proficiency in writing (Akbarani, 2024).

One of the activities that we have carried out in English writing classes, in groups of 15 students, was to require students to correct their essays with ChatGPT, asking for a list of errors regarding sentence structure, grammar, vocabulary, spelling and punctuation. Next, students had to correct each mistake in their original draft and ask if they did not understand some of the mistakes they made. Together we have discussed some of the most common errors encountered, to make sure they learn from their mistakes. After that, students required ChatGPT to refine their essays at an advanced level, and students were supposed to decide what they would implement from the suggestions given by ChatGPT. The class was a success because every student worked at their own pace, received immediate and personalized feedback and they actively engaged in class.

However, the incorporation of ChatGPT does not come without challenges. Just like using AI in general, the issue of over-dependence, as well as concerns regarding the authenticity of student work, must be addressed. Some scholars argue that although AI can enhance the learning process, students may become dependent on AI, potentially damaging their critical thinking and writing skills (Liu, 2023). Thus, educators are encouraged to maintain a balance, using AI as a support mechanism and not a substitute for traditional teaching and learning. Continuous feedback and adaptation will be essential to maximize its potential while safeguarding the integrity of academic learning.

3.2. Integration of Scoring Rubrics

Assessing student work through AI-based tools in language classes presents unique opportunities and challenges for educators. Writing scoring rubrics are essential for providing structured and consistent assessments. When using AI in foreign language writing assessments, these rubrics can be fine-tuned to incorporate AI-generated insights into students' performance. For instance, educators can design rubrics that evaluate students on specific criteria, such as complexity of language, fluency, and grammatical accuracy, while referencing insights from AI tools. This can help ensure scoring is both qualitative and quantitative, providing a proficient evaluation of student work.

Furthermore, engaging students in co-creating rubrics can enhance their motivation and understanding of assessment expectations (Gong, 2023). This collaborative approach

empowers students and promotes critical thinking as they actively participate in evaluating their peers' work.

3.3. Using Peer Feedback through AI

Peer assessment is an effective method to evaluate student writing while also encouraging collaborative learning among students. Educators can utilize AI tools to facilitate peer feedback processes by generating prompts and guiding questions for students to reflect on their peers' drafts (Harunasari, 2023). For example, ChatGPT can assist students in developing constructive feedback, ensuring that the review process is clear and based on specific criteria outlined in the rubrics.

This AI peer review process can increase student engagement and responsibility for their work, as reflected in studies showing students respond positively to peer assessment initiatives (Ekizoğlu & Demir, 2025). Moreover, using AI to analyze peer feedback can provide educators with insights into common areas of misunderstanding or strengths among students, informing future instructional strategies.

3.4. Formative and Summative Assessment Enhancement

AI tools can complement traditional formative and summative assessments by enabling real-time monitoring of student performance. Language learning applications that incorporate AI can track progress over time by documenting improvements in writing capabilities (Wei, 2023). These tools can automatically assess drafts and provide analytics that inform both students and teachers about growth in specific areas, such as vocabulary usage or sentence complexity.

Moreover, educators should consider integrating AI evaluations with traditional assessments to create a holistic view of a student's language abilities. By combining AI's real-time feedback capability with formal examinations or written assignments, teachers can create a more comprehensive assessment experience that considers both structured and informal learning environments.

3.5. Emphasizing Academic Integrity and Ethical Use

Although AI tools offer significant advantages for assessment, it is crucial to consider potential ethical problems, particularly regarding plagiarism and academic integrity. Educators must be proactive and inform learners about the limitations and appropriate use of AI. Expectations for original work and rules on academic integrity are essential for creating a responsible and ethical learning environment (Khalil & Er, 2023).

Encouraging students to use AI to enhance their writing rather than solely relying on it for completion can stimulate students to take responsibility for their work and education. Educators can integrate discussions about the ethical implications of AI into the

curriculum, ensuring that students understand the balance between using technology and maintaining academic integrity (Liu & Wang, 2024; Khalil & Er, 2023).

4. Conclusions

Incorporating AI-based tools in assessing student work offers dynamic and multifaceted approaches to evaluation. By using AI for immediate feedback, structured rubrics, facilitating peer assessments, enhancing formative assessment processes, and emphasizing academic integrity, educators can create a supportive and effective assessment environment. These strategies not only improve language proficiency among learners but also prepare them for an increasingly digital and automated learning future.

The effective use of AI technologies in language instruction and acquisition requires proactive engagement from both educators and students. By encouraging AI literacy, personalizing learning experiences, and promoting collaboration, both parties can maximize the benefits of these technological advancements. Furthermore, attention to academic integrity and the constructive use of feedback will enhance the overall educational experience. In order to succeed in a foreign language class, we need to remain adaptive and open to new methodologies.

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AI in ESP Classes: Case Study on Education Students

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This paper explores the integration of Artificial Intelligence (AI) in English for Specific Purposes (ESP) classes, focusing on a case study involving first- and second-year students enrolled in the Preschool and Primary School Education programme at "Aurel Vlaicu" University of Arad. Grounded in a theoretical framework that intersects language acquisition, and educational technology, the study investigates how AI-driven tools can support the development of both English language proficiency and teaching competences. The research involves implementing AI applications to design and generate customized teaching materials, interactive tasks, and classroom activities tailored to the specific needs of future educators. Findings highlight the potential of AI to enhance learner engagement, foster autonomy, and promote a more dynamic approach to ESP instruction. The study also reflects on the pedagogical implications and practical challenges of incorporating AI in teacher education programs, offering insights and recommendations for educators and curriculum designers.

ESP; AI; digital platforms; digital tools; multimodal teaching.

1. Introduction

The rapid advancement of Artificial Intelligence (AI) has transformed the landscape of language learning and teaching. The same has happened in the field of English for Specific Purposes (ESP) where many applications are available for teaching, assessment and self-assessment. Unlike General English instruction, ESP focuses on equipping learners with language skills tailored to professional, academic, or occupational domains. This requires instructional approaches that are context-sensitive, adaptive, and capable of addressing specialized linguistic and communicative demands. AI technologies—ranging from natural language processing and adaptive learning platforms to intelligent tutoring systems and generative models—offer novel opportunities to enhance these processes.

In recent years, the integration of AI into ESP has been driven by several factors: the need for personalized learning pathways, the availability of large-scale domain-specific corpora, and the growing demand for flexible, technology-supported instruction in globalized professional environments. AI-based tools can analyse learner performance in real time, provide automated feedback, simulate authentic communicative scenarios, and generate domain-specific learning materials.

At the same time, the use of AI in ESP raises questions about pedagogical alignment, reliability, ethical considerations, and the evolving role of instructors. While AI can facilitate adaptive and data-driven instruction, its implementation requires careful examination of its effectiveness, accessibility, and implications for learner autonomy and professional identity. Thus, a systematic exploration of AI's role in ESP is necessary.

This article offers an insight into the literature on AI use in ESP and presents certain AI-driven activities conducted during ESP classes with students enrolled in Education studies at" Aurel Vlaicu" University of Arad, Romania.

2. Literature review

AI has significantly transformed education and English language teaching in the past years. Willing or not, teachers have to adapt because this generation of learners has been exposed to technology since their primary school and traditional teaching no longer functions. We are aware of the fact that learners use AI for projects, lesson planing, activities, portfolios etc and therefore a teacher-guided and controlled use of AI during ESP classes can become beneficial for teachers and students alike.

Studies have been written on the usefulness of using AI in ESP classes, thus seeking to highlight the pedagogical implications of AI integration in the ESP classroom. Shin (2018) advocates for the use of AI technology in blended classes, finding out that students who had been exposed to AI, had significantly developed their speaking, listening and reading skills. The study also highlights the fact that teachers who use AI in their classes are more creative, develop personalized teaching activities tailored on the students` real needs and are better at offering a personalized feedback. Liu at al (2021) reveal that AI tools helped students improve their writing skills through creative writing activities. Jiang (2022) has concluded that AI-powered tools have been successfully integrated into teaching English. Intelligent tutoring systems, chatbots, neural machine translation, and adaptive learning systems are among the most commonly used features of AI. These tools have been integrated in ESP classes as well. They have been adapted to specific activities such as grammar, vocabulary and tense practice (Kovačić, A., & Bubaš, G. (2023). Istrate (2018) even suggested the implementation of an artificially intelligent e-learning platform, tailored to the students` needs that would allow one-to-one interaction through a chatbot.

In this respect, ESP classes should be more technology-driven, more interactive and obviously more adapted to the features of this generation of learners. However, not only teaching materials and methods have and will change but also the teacher and teacher`s role. Apart from being course designer, teacher, researcher, assessor, the new ESP teacher should be very well equipped with digital skills and constantly update them as technology is changing and evolving really fast. Bouguebs at al. (2023) state that teachers will have to fulfill the multiple roles attributed to them in the ESP classroom but will also have to meet

the students` needs in this digital age. ESP classes will be reshaped by the use of new modes of teaching and learning, including chatbots and other AI tools.

Among the most useful, user-friendly and efficient AI tools, we list the following:

- Language learning apps: Duolingo, Rosetta stone etc in their most recent versions have AI incorporated tools, gamification features, adaptive learning techniques. They can create an interactive, challenging and engaging experience, helping learners to retain content and have an enjoyable learning experience.
- Speaking Practice: Speeachace, Elsa Speak, Luvvoice are created to help learners improve their pronunciation, speaking skills and increase their confidence in oral interaction. They signal misprounciations and offer remedial feedback to correct where and when necessary.
- Writing practice: Grammarly is among the most common apps for writing activities. It provides feedback, identifies grammar, spelling and lexical/word choice mistakes and helps in the error correction process.
- VR: provides an immersive learning environment. Personally, I did not have an encouraging and pleasant experience with a VR app for English learning but possibly, there are better solutions.
- Interactive practice and real-time support: Chatbots and virtual tutors help students and guide them through interaction, conversations, role plays. They provide immediate feedback on gramamr, vocabulary, pronunciation issues. The advantage as compared to a human tutor is that it can be accessed outside the classroom and the interaction can take place anytime and anywhere.
- Educational content: AI helps teachers create educational content such as worksheets, quizzes, comprehension questions, thus reducing te teacher`s preparation time. They also offer a variety of tasks, activities and games, encouraging students to get involved in the learning process. We shall mention Padlet, Wordwall or Quillionz here.

3. Methodology

In the academic year 2024-2025, we tried to integrate AI tools in the ESP course for undergraduate students enrolled in Preschool and Primary School education programme. Students study English applied in education for 2 hours/week during the first four semesters. We tested them at the beginning of their academic path and the results revealed that most of the students are at B1-B2 level with minor exceptions below B1. The activities referred to in this study were conducted during the second semester and at the end, we applied a questionnaire that was submitted to the students via Google forms. The answers were anonymous thus giving students more freedom to express their opinions. There are 120 students enrolled in this programme; however, most of them have completed the English course during another bachelor programme and the credits were transferred as part of the ECTS system. Given the situation, the attendees of the ESP course were around 60.

The sample consisted of female students, aged 18 to 60. As teaching procedure, we tried to integrate as many technologies as possible without overuse of ICT. During most classes students were made familiar with different apps such as: ChatGPT, Luvoice, Padlet, PowerPoint features, the AI features of Cambridge, turboscribe AI, Canva etc.

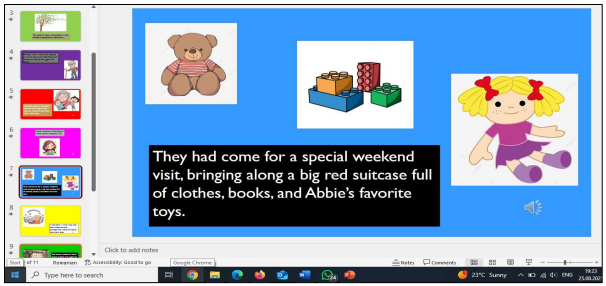
A particular activity that we would like to refer to and mention here is part of their final assessment portfolio. Students had to create a digital story with activities for primary school students using AI and other 2 apps, recorded either with Canva or with PPT. They could work individually, in pairs or in small groups, but preferably individually or in pairs. Usually, when working with undergraduate students enrolled in education programmes, we prefer group work to develop their language and communication skills during ESP classes because each student gets the change to make a valuable contribution to the group. Maybe not all are equipped with proficient language skills but can add value to the tasks with other skills like crafting, creativity, painting, drawing, imagination etc. All these qualities and skills are required for a successful preparation of any activity in primary school.

The work procedure for the preparation of a digital story consisted of the following steps:

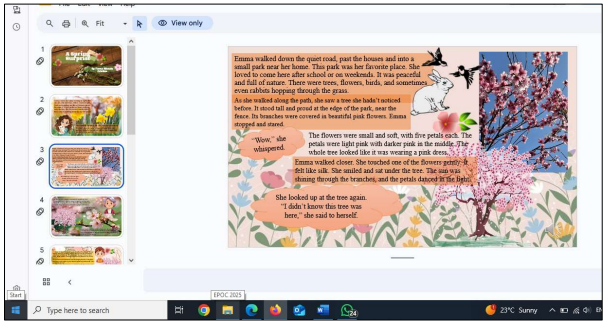
1. They had to think about a title or a topic for their story.
2. Then, with the help of Padlet, they had to prepare a key picture as the cover of their digital book. Padlet requires certain keywords to prepare the picture, therefore students had to submit this short list of words.
3. Based on the picture and title, students had to ask ChatGPT to create a longer list of words suitable for primary school students (about 10-15 words).
4. Based on this list, picture and title, students had to prepare two pre-reading activities, one with pen and paper and a digital one using Wordwall.
5. Next step was to create the story. Students had to introduce the title, the list of words and the characters of the story in the chat and create the story within a limited or preset number of words.
6. As a digital audio book requires clear and correct pronunciation, students used Luvoice to prepare their audio version. For those who are unfamiliar with the app, one can add a text in the app, select the language or the dialect, the gender of the reader and the app offers a correct reading in the selected language. It is a good app to train and practice students` pronunciation either in the classroom or outside.
7. After training their correct pronunciation, students had to prepare the pictures to be inserted in the story in Canva or any other app (Padlet, for instance).
8. When the text, the pictures and the pronunciation were ready for the final stage, students had to turn the material into an audiobook. We advised them to use PPT (older version for recordings or newer one for recording with video), Canva or any other app that contains presentation features.

9. In the end, they had to prepare 2 after reading activities, one paper and pen and a digital one.
10. When the product was ready, students presented it in front of their classmates and were assessed for their work.

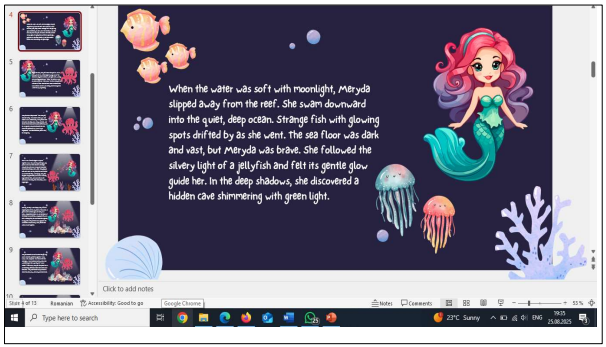
Below, we shall present some of the students` digital audiobooks.



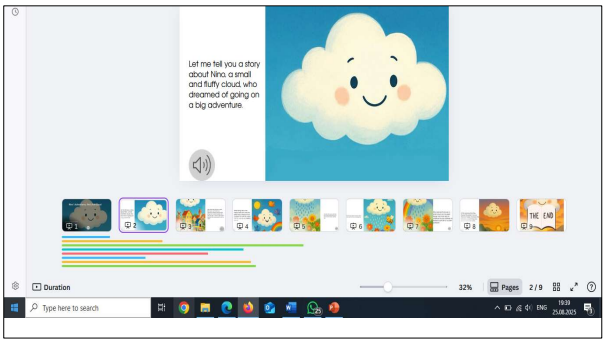
Source: personal archive (digital story 1st sample)



Source: personal archive (digital story 2nd sample)



Source: personal archive (digital story 3rd sample)



Source: personal archive (digital story 4th sample)

To conclude with this part of the paper, we encourage the use of technologies in ESP classes as they turn them into a challenging, creative and skill-developing environment. From our experience, we can state that students feel more encouraged to take part in activities, to create materials, present them in front of their peers. They even tend to forget their public speaking fears in English, they are willing to interact with other classmates, share ideas, learn vocabulary and develop their skills.

Among the most important benefits, we shall mention the development of:

- ✓ Vocabulary for specific purposes;
- ✓ Communication skills;
- ✓ Pronunciation skills;
- ✓ Writing skills;
- ✓ Presentation skills;
- ✓ Critical thinking skills;
- ✓ Digital skills
- ✓ Team work abilities

4. Results and discussions

As mentioned, we conducted a study on a sample of 1st year education students. Out of 60 students that were qualified to answer the questionnaire, we collected 46 responses.

48.8% are aged 18-30, 39%, 31-45 and 12.2% are aged 46-60.

Surprising or not, given the age distribution, 95.7% believe that technologies are useful in education whereas 4.3% answered" maybe". We hadn`t recorded any negative answers. Although not all respondents belong to Generation Z which is used to gadgets and devices, all respondents acknowledged that technology plays a crucial role in contemporary education.

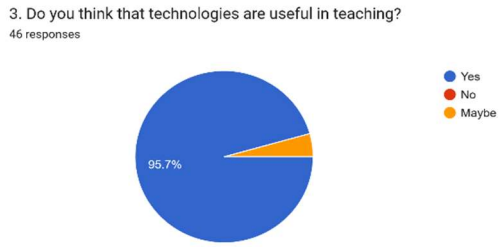


Chart no 1 *Do you think that technologies are useful in teaching?*
Source: personal archive

Even if Romanian education still suffers from traditionalism or as stated, professors tend to deliver lectures in a more traditional manner with less reliance on technology, 100% of the respondents stated that their teachers used technology. It is a sign that education is a vivid organism that adapts to the changes in the society and to the features of traits of this generation of learners.

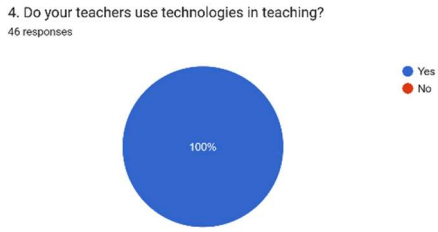


Chart no 2 *Do your teachers use technology?*
Source: personal archive

Another question that we would like to discuss here refers to the frequency of technology use. 56,5% of the respondents state that teachers use technology quite often, whereas 23,9% consider that technology is used during every lecture and 19,6% state that they are sometimes exposed to technology.

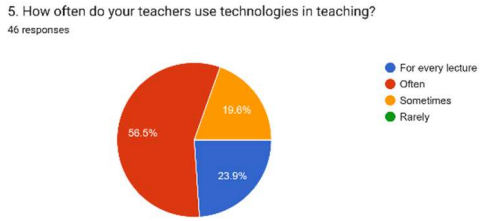


Chart no 3 *How often do your teachers use technology?*
Source: personal archive

We have further analysed the specific situation of ESP classes. 95,7% of the students mention that they are exposed to technology during their English classes and 4.3% consider that they are not. Though small, the percentage is quite strange as all students benefit from the same activities and ICT exposure. Probably, the question was not well understood by those 4.4%.

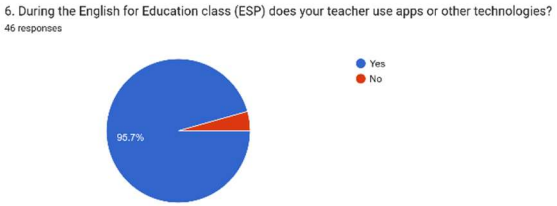


Chart no 4 *During the English for Education class (ESP) does your teacher use apps or other technologies?*
Source: personal archive

91,1% believe that such activities are useful and only 8.9% would prefer more traditional activities.

One question investigated the students` familiarity with certain apps. The list is quite substantial but the apps that are mention the most are: ChatGPT, Canva, Duolingo, Luvoice, Powerpoint, Adservio, Youtube etc.

We have also analysed the students` opinion about AI use in ESP classes. 58,7% consider that it is useful and 26,1% believe it is a challenging task. An interesting finding is that none (0,00%) of the respondents considers that use of AI as a non-ethical activity.

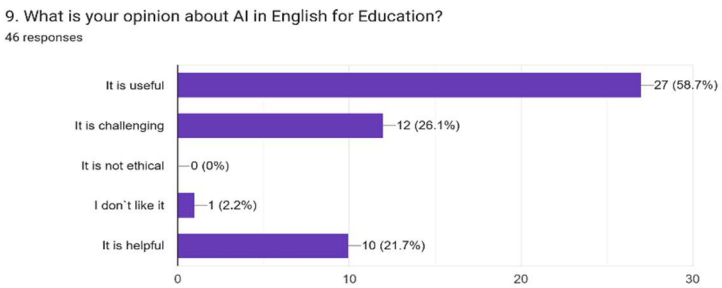


Chart no 5 *What is your opinion about AI in English for education?*
Source: personal archive

In terms of usefulness during classroom activities, students believe that AI could help them in finding information (73,9%), preparing presentations (67,4%), story writing (60,9%), or translation (58,7%). Other findings can be seen in the chart below.

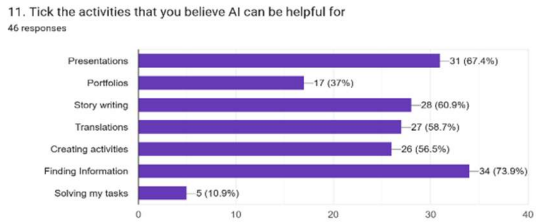


Chart no 6 *Activities with AI*
Source: personal archive

An interesting finding is revealed by the chart below. Only 23,9% would trust AI in assisting teachers during assessment activities. 39,1% are not yet decided and almost the same percentage state they wouldn`t (37%).

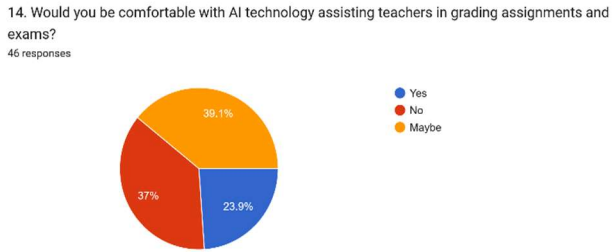


Chart no 7 *Would you be comfortable with AI assisting teachers in grading?*
Source: personal archive

The apps that students have used or prefer are listed in the chart below. We can see that they are familiar with ChatGPT (91,3%), Duolingo and Google Translate (80,4%), Kahoot (56,5%).

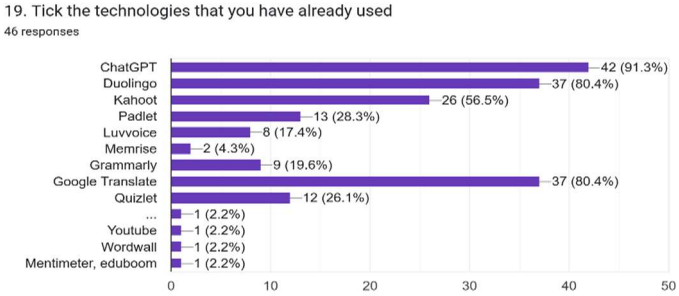


Chart no 8 *Used technologies*
Source: personal archive

In terms of digital tool used for education purposes, most students use laptops (95,7%) PPTs (84,8%), smartphones (82,6%) or emails (78,3%). Other findings are presented in the chart below.

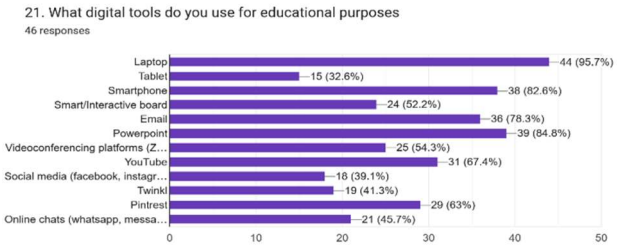


Chart no 9 *Digital tools for educational purposes*
Source: personal archive

The last aspect that we want to present refers to the activities that students used AI for. Many students search for information though we have warned them about potential false information. They also use AI for translations, to create stories, presentations, worksheets or lesson projects.

We have selected the most relevant answers from the questionnaire. The research reveals that students are familiar with technologies, use them and enjoy working with them. In terms of ESP relevance, most of them consider that skills can be developed using AI and technologies (34,8%) and the same percentage believe that AI has to be integrated properly to enhance and improve students` language skills. Only 10,9% disagree with the statement.

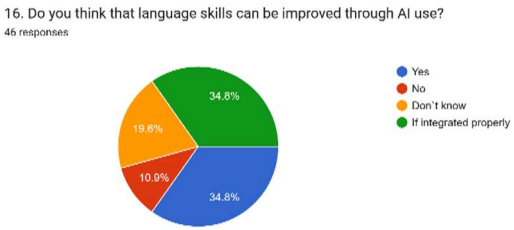


Chart no 10 *Skill development*
Source: personal archive

5. Conclusions

Needless to say, that technologies and AI can be of great support in ESP teaching and assessment if used carefully, appropriately and responsibly. Results have shown that students appreciate digital activities when familiar with the app. They are also eager to discover new apps that would later on introduce in their lessons during pre-service stages

and as teachers. Technologies and AI make the lessons more adapted to the learners` needs, by offering tailored materials, vocabulary, and simulations relevant to their specific field. Another benefit is that digital platforms and AI-driven resources provide learners with authentic materials—such as simulations, worksheets or role-plays—that replicate real life and workplace communication. Multimedia tools, interactive platforms, and AI chatbots encourage learner participation, making ESP lessons more dynamic and motivating compared to traditional methods. They also support independent work and practice, favouring learning outside the classroom.

For teachers, technologies and AI help in preparing context-specific content, assessing progress, and providing instant feedback, freeing up time for more interactive and communicative activities.

Despite the benefits, teachers must address challenges such as digital literacy gaps, over-reliance on AI, and the need for critical evaluation of AI-generated content. On the other hand, ethical issues should also be taken into account. Creating texts and materials should be carefully considered not to be considered plagiarism. Such materials can be used as classroom support, mentioning that they were AI generated and not used for publication purposes without mentioning the source.

All in all, AI and technologies are a good and efficient tool in ESP classes, making they more use-friendly, challenging and creative.

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Der KI-Prompt – Eine (neue) Textorte für den DAF-Unterricht? Eine Analyse aus textlinguisticher Sicht /

The AI Prompt – A (New) Text Type for German as a Foreign Language (GFL) Teaching? An Analysis from a Text Linguistics Perspective

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This paper aims to analyze AI prompts from a linguistic perspective in the context of teaching German as a foreign language, drawing conclusions for university-level teaching practice. Instructions written in the context of communication with artificial intelligence exhibit text-like characteristics and can be classified as a text type. This paper argues for the expansion of the range of text types covered in German as a foreign language teaching to include AI prompts.

Prompt Engineering; German as foreign language; AI prompts; text type.

1. Einleitung und Zielsetzung

„Wie man in den Wald hineinruft, so schalt es heraus“ lautet ein bekanntes deutsches Sprichwort, das darauf hinweist, dass die Reaktion, die wir im Rahmen der Kommunikation

bekommen, von der Art und Weise abhängt, wie man das Gemeinte formuliert. Dieses Sprichwort gilt umso mehr, wenn es um die Kommunikation mit der künstlichen Intelligenz geht, insbesondere bei der Kommunikation mit den Chatbots, so wie ChatGPT[1] oder Copilot[2]. Dabei steht der Output, sprich das gelieferte Ergebnis im direkten Zusammenhang mit dem Input, anders formuliert hängt die Antwort, die man vom Sprachmodell bekommt, davon ab, wie man die Anleitung, die Aufgabe man dafür formuliert.

Dass ChatGPT, Copilot und ähnliche KI-Instrumente heutzutage als Nummer 1 Instanz für die Beantwortung von Fragen oder Lösen von Aufgaben im schulischen[3] und beruflichen Kontext gelten, geht aus der Hand, da wir in einer KI-gesteuerten Welt[4] leben. Die KI-Kompetenz (*engl. AI-Literacy*) wird als Kompetenz immer wichtiger[5], sodass auch im Hochschulbereich immer mehr investiert wird, diese Kompetenz zu entwickeln.

> Creating a culture of AI adoption in educational institutions is crucial. This culture should be built on the principles of ethical AI use, continuous learning, and critical engagement with technology. It involves not just the implementation of AI tools but also the fostering of an environment where questioning, exploring, and critically assessing AI is encouraged. This culture should permeate all levels of the institution, from policy-making to classroom activities. Encouraging students to question and explore AI's potential and limitations can lead to a deeper understanding and responsible use of these technologies. This includes facilitating discussions on topics such as AI's impact on job markets, privacy concerns, and the implications of AI in decision-making processes. By encouraging critical thinking around these

[1] OpenAI. (2025). [Large language model]. ChatGPT. https://chat.openai.com/
[2] Microsoft. (2025). Copilot [Large language model]. Microsoft. https://copilot.microsoft.com
[3] Ich unterrichte seit mehr als 15 Jahren Wirtschaftsdeutsch an der Fakultät für Wirtschaftswissenschaften und Unternehmensführung der Babes-Bolyai-Universität.
[4] Additionally, the focus on AI literacy, prompt engineering, and critical thinking skills prepares students for the complexities of a technology-driven world, equipping them with essential competencies for the future. Walter (2024, S. 25)
[5] Vgl. u. a. Lee und Palmer (2025, S. 6), die die Ergebnisse mehrerer seit 2022 durchgeführten Studien präsentieren, die gemeinsam die Schlussfolgerung haben, dass die KI-Kompetenz eine der wichtigsten Kompetenzen für den Arbeitsmarkt in der nahen Zukunft werden wird. Ferner plädieren die Autoren für die Einführung eines entsprechenden Curriculums im Hochschulbereich.

topics, students can develop a nuanced understanding of AI, equipping them with the skills necessary to navigate an AI-driven world. (Walter, 2024, S. 24)

Das Konzept KI-Kompetenz (engl. *AI Literacy)* umfasst "understanding and capability to interact effectively with AI technology. It encompasses not just the technical know-how but also an awareness of the ethical and societal implications of AI" (Walter, 2024, S. 11). Aus diesen Überlegungen stammt die Forschungsfrage der vorliegenden Arbeit, und zwar, inwieweit der KI-Prompt die Merkmale einer Textsorte im Sinnen der Textlinguistik erfüllt und daraus ausgehend, zu überlegen, welche Möglichkeiten es gibt, diese im DaF-Unterricht je nach Sprachniveau zu thematisieren, da die Textsortenkompetenz eine wichtiger Bestandsteil der Schreibkompetenz in der Fremdsprache ist. Zunächst werden die theoretischen zugrunde der Arbeit gelegten Konzepte geklärt und der KI-Prompt aus textlinguistischer Perspektive analysiert, wobei in dem zweiten Teil die Thematisierungsmöglichkeiten[6] im DaF-Unterricht präsentiert werden.

2. Theoretische Grundlagen – Textlinguistik, Textsorte, Prompt-Engineering

In der Forschungsliteratur zu der Textlinguistik gibt es Einigung darüber, dass DIE Definition eines Textes nicht geschrieben werden kann. Einige der häufig in der Literatur zitierten Definitionen sind die Definition von Brinker (2001, S. 17): „Der Terminus, 'Text' bezeichnet eine begrenzte Folge von sprachlichen Zeichen, die in sich kohärent ist und die als Ganzes eine erkennbare kommunikative Funktion signalisiert (Brinker, 2001, S. 17), die Definition von (Dressler, 1972, S. 1), der der Text als „eine abgeschlossene sprachliche Äußerung" verfasst oder die folgenden Definitionen: „The word TEXT is used in linguistics to refer to any passage, spoken or written, of whatever length, that does form a unified whole" (Halliday & Hasan, 1976, S. 1) und „ein Text ist ein durch ununterbrochene pronominale Verkettung konstituiertes Nacheinander sprachlicher Einheiten" (Harweg, 1968, S. 148). Aus dieser Sicht stellen zunächst auch die Anleitungen, die wir an den Chatbots für die Durchführung bestimmter Aufgaben Texte dar.

Allen Definitionen ist die Funktionalität eines Textes gemeinsam, indem Texte bestimmte sprachliche Funktionen erfüllen.[7] Adamzik (2004, S. 49) fasst sieben Merkmale

[6] Vgl. dazu auch „Die Bildungsinstitutionen, die Sprachunterricht anbieten, sowie die Sprachlehrenden müssen sich mit dieser disruptiven Technologie aktiv auseinandersetzen und die Chancen, die der Einsatz von KI bietet, didaktisch-methodisch sinnvoll nutzen. Zugleich müssen alle beteiligten Akteurinnen und Akteure die Risiken und Herausforderungen des KI-Einsatzes sowie die Akzeptanz dieser Technologie thematisieren Kohnke, Moorhouse, and Di Zou (2023, S. 545)

[7] Vgl. dazu auch „Wenn man einen Text als Folge von Sätzen oder als komplexes Zeichen-Gefüge ansieht, unterstellt man von vornherein eine gewisse Länge und klammert damit Äußerungen aus, die nur aus einem (eventuell auch noch unvollständigen) Satz oder gar nur aus einem Wort bestehen *(Eintritt verboten; Privatgelände* usw.), obwohl auch diese abgeschlossene kommunikative Akte darstellen. Dennoch besteht allgemeiner Konsens darüber, dass

von Texten auf, die in einer oder anderer Form in der Forschung zur Textlinguistik auftreten. Diese Merkmale sind:

1. Die *Kohäsion* als Ausdruck der „Verbindung der Worte in der Textoberfläche“
2. Die *Kohärenz („* semantischer Textzusammenhang“)
3. *Die Intentionalität (*Textabsicht)
4. Die *Akzeptabilität „* als Einstellung des Rezipienten, der die vorliegenden Sprachäußerungen als Text anerkennt“
5. Die *Informativität „* als Kennzeichen der Neuigkeit und Unerwartetheit eines Textes“
6. *Die Situationalität „* als Situationsangemessenheit des Textes“,
7. *Die Intertextualität „* als Ausdruck der Abhängigkeit von anderen Texten."

Textlinguistisch betrachtet können die Prompts als Texte unterschiedliche Länge und sprachliche Komplexität aufweisen, je nach der Funktion, die sie erfüllen müssen. In der Literatur zum *Prompt Engineering* werden unterschiedliche Arten oder Frameworks für das Verfassen von Prompts präsentiert, wobei unter Prompts „natural language instructions that provide context to guide the model or learned vector representations that activate relevant knowledge. (Sahoo et al., 2024, S. 1) verstanden wird. Die aufgabenspezifischen Anleitungen verfolgen das Ziel „to enhance model efficacy without modifying the core model parameters. (Sahoo et al., 2024, S. 1). Im DUDEN-Onlinewörterbuch wird ein Prompt, wie folgt definiert:

> [meist natürlichsprachliche] Eingabe, die als Aufgabenbeschreibung für generative Modelle künstlicher Intelligenz zur Erzeugung von Texten oder Bildern dient (zum Beispiel „Verfasse eine lustige Geschichte über eine Ameise, die nach Amerika reist!“ [für einen Text] oder „eine Katze klettert einen Baum hoch, impressionistisch“ [für ein Bild])[8]

In diesem Sinne müssen die KI-Prompts nicht nur durch Kohäsion und Kohärenz, sondern auch durch eine bestimmte Absicht gekennzeichnet werden. Man will die künstliche Intelligenz dazu bringen, eine Aufgabe auf eine für den Inputgeber zufriedenstellende Art und Weise zu lösen. „Akzeptabilität ist ein Rezipienten zentriertes Merkmal und meint, dass jeder Text, wenn er wahrgenommen wird, von Rezipienten mit

solche‚Kurz-Texte' allenfalls Randphänomene sind und zweifellos keine guten Beispiele für die Kategorie *Text* darstellen.“ Adamzik (2004, S. 44)

[8] https://www.duden.de/rechtschreibung/Prompt, abgerufen am 15.11.2025

einer bestimmten Erwartungshaltung gelesen wird“ (Schwarz-Friesel & Consten, 2014, S. 19) was im Falle der Mensch-KI-Kommunikation bedeutet, dass der Verfasser, die Anweisung so formulieren muss, dass das System es versteht und entsprechend Rückmeldung gibt. Die *Situationalität* stellt einen wichtigen Aspekt beim Verfassen der KI-Prompts, da sie „die kontextuelle Einbettung jedes Textes“ anspricht: „Texte werden nicht kontextfrei, sondern stets in bestimmten Situationen (also Raum-Zeit-Konstellationen) produziert bzw. rezipiert (Schwarz-Friesel & Consten, 2014, S. 19).

Diese Merkmale dienen nicht nur dazu Texte zu beschreiben, sondern werden auch als Grundlage zur Definition von *Textsorten* gelegt. Was der Begriff *Textsorte*[9] anbelangt, ist mit (Janich, 2019, S. 139) festzustellen, dass

> unter den Ausdruck Textsorte die unterschiedlichsten Konzepte gefasst werden, neben Witz, Beschreibung oder Erzählung fallen darunter argumentativer Text und Übersetzung ebenso wie Brief oder Gespräch beim Abendessen, und selbst bei Versuchen einer gewissen Systematisierung und vergleichenden Gegenüberstellung erscheinen als ‚Alternativ‘-Ausprägungen Kategorien wie Zeitungstext vs. ökonomischer vs. politischer Text usw. (vgl. (Isenberg, 1978, S. 569), obwohl ja offenkundig ist, dass ein Text dies alles gleichzeitig sein kann (Janich, 2019, S. 139).

Die am häufigsten zitierte Definition einer *Textsorte* ist die folgende Definition von Brinker (1985, S. 124): „Textsorten sind konventionell geltende Muster für komplexe sprachliche Handlungen und lassen sich als jeweils typische *Verbindungen* von kontextuellen (situativen), kommunikativ-funktionalen und strukturellen (grammatischen und thematischen) Merkmalen beschreiben.“ In der Literatur zu den Textsorten werden unterschiedliche textinterne oder textexterne Merkmale zugrunde der Textsortenklassifikationen gelegt (vgl. dazu. auch die tabellarische Übersicht bei Janich (2019, S. 155).

Darunter sind die vier Merkmale von Adamzik (2016) für das Forschungsvorhaben der vorliegenden Arbeit von Bedeutung: *die sprachliche Gestalt, das Thema/der Inhalt, die Funktion und der situative Kontext*. Wie oben angeführt wird der KI-Prompt in der Literatur als eine Anweisung an die künstliche Intelligenz definiert, mit dem Ziel, durch sprachliche Eingaben bestimmte Denkprozesse, Formate oder Antwortstile zu erzeugen. Da es sich um die Kommunikation Mensch-Maschine handelt, spielt der Input eine

[9] Andere „konkurrierende Begriffe“ sind so Adamzik (2004, S. 102), Textmuster oder Texttyp.

ausschlaggebende Rolle. Der Fachbegriff dazu ist *Prompt Engineering*[10] und bezieht sich auf die Art und Weise, wie die KI gesteuert werden kann, um zu bestimmten Ergebnissen zu gelangen. Das Engineering bezieht sich auf die sprachliche Gestaltung der Prompts, das heißt, je nachdem wie die Anweisungen sprachlich gestaltet werden, werden, wird auch der Output, also die KI-Antwort gestaltet.

3. Inwieweit kann der KI-Prompt als eine Textsorte im Sinne der Textlinguistik betrachtet werden?

Im Rahmen des vorliegenden Kapitels liegt der Fokus der Überlegungen darauf, inwieweit je nach Sprachniveau, die KI-Prompts zu den Kategorien der im Unterricht behandelten Textsorten mitberücksichtigt werden können. Als Grundlage für die Beantwortung der obigen Frage schließe ich mich (Adamzik, 2004, 2016) ab, die die folgenden vier Merkmale zur Definition einer Textsorte festlegt: *die sprachliche Gestalt, das Thema/der Inhalt, die Funktion und der situative Kontext.*

Was die sprachliche Gestalt der KI-Prompts anbelangt, lässt sich feststellen, dass diese unterschiedliche sprachliche Gestaltung aufweisen können, von den einfachen Anweisungen, die nicht viele Sprachkenntnisse für den Produzenten, Fremdsprachler fordern, bis hin zu den komplexeren, die als Formulierung auch für die Muttersprachler problematisch sein können. Bereits auf A1/A2-Niveau in der Fremdsprache lassen sich grundlegende Steuerungsformen der Sprachmodell, wie ChatGPT oder Copilot lehren und lernen. Dazu gehören zum Beispiel neue Aufgaben, die ohne Training ausgeführt werden können (engl. *New Tasks Without Extensive Training* (Sahoo et al., 2024, S. 2)). Zu dieser Kategorie gehören folgende Arten von Prompts

> *Zero-Shot prompts:* There are no specific examples added.
>
> *One-Shot prompts:* One specific example is added to the prompt.
>
> *Two-Shot prompts:* Two examples are added to the prompt.
>
> *Three-Shot prompts:* Three examples are added to the prompt.
>
> *Few-Shot prompts:* Several examples are added to the prompt (unspecified how many). (Walter, 2024, S. 14)

[10] Sahoo et al. (2024) fassen 41 Prompting-Strategien aus der bestehenden Literatur zum Thema zusammen und bieten eine klare Übersicht über alle bis zu dem Zeitpunkt mittels unterschiedlicher Studien erprobten Strategien für effizientes Prompten bei der Kommunikation mit großen Sprachmodellen an.

Diese Prompts die sprachlich den Imperativ oder häufige Verben in Präsens benötigen können schon auf A1 Niveau thematisiert werden. Ein Beispiel für den DaF-Unterricht kann sein: *Ich lese, du liest; ich fahre, du fährst. Gib mir weitere 10 Beispiele.*

Hier auch die Copilot-Antwort:

Natürlich! Hier sind 10 weitere Beispiele von deutschen Verben, bei denen sich der Stammvokal in der 2. Person Singular (du) verändert:

🧠 ***Verben mit Vokalwechsel im Präsens***	
Infinitiv (ich)	***2. Person Singular (du)***
ich sehe	*du siehst*
ich gebe	*du gibst*
ich nehme	*du nimmst*
ich spreche	*du sprichst*
ich treffe	*du triffst*
ich helfe	*du hilfst*
ich esse	*du isst*
ich laufe	*du läufst*
ich schlafe	*du schläfst*
ich trage	*du trägst*

*Diese Verben gehören zu den sogenannten **starken Verben**, bei denen sich der Stammvokal in bestimmten Formen verändert – besonders bei „du" und „er/sie/es". Möchtest du auch eine Liste mit den häufigsten dieser Verben oder eine Übung dazu?*

Beleg 1 Copilot-Antwort starke Verben[11]

Auf der Mittelstufe und auf dem Fortgeschrittenen Niveau können m.E. nach unterschiedliche Textmuster thematisiert werden, wobei mit den Lernenden unterschiedliche Bausteine bearbeitet werden können, die sie dann, je nach Bedarf in unterschiedlichen Kontexten umsetzen. Die folgende Tabelle enthält einige solche Textmuster, die mithilfe von Copilot[12] recherchiert worden sind. Wie aus der Tabelle hervorgeht, können die Vertextungs-Strategien[13] mithilfe von Akronymen zusammengefasst und definiert werden.

[11] Microsoft. (2025). Copilot [Large language model]. Microsoft. https://copilot.microsoft.com, abgerufen am 15.11.2025

[12] https://copilot.microsoft.com, abgerufen am 15.11.2025

[13] Eine tiefere Beschreibung solcher Strategien könnte den Gegenstand einer folgenden Arbeit darstellen.

P – osition *A – ufgabe* *D – etails* *S – til*	*R – olle* *A – udience (Zielgruppe)* *C – ontext (Kontext)* *E – xpectation (Erwartung)*
C – ontext *E – xplizit* *N – "nett" sein – Aktivierung – Ton, Stil* *T – Ziel definieren* *E – rwartung* *R – eden / Interaktion*	*P – urpose (Ziel)* *R – olle* *O – output (Erwartung)* *M – echanism (Format und Struktur)* *P – arameter* *T – on*
C – intext *L – anguage (Ton und Stil)* *E – xamples* *A – aufgabe* *R – esponse*	

Beispiel 2 Prompts-Muster -Copilot-Antwort[14]

Insbesondere für den Wirtschaftsdeutschunterricht finde ich es sinnvoll, solche Textmuster zu thematisieren und zu lehren, da die Studierenden sich am Anfang ihres beruflichen Werdegangs befinden und sie diese Textsortenkompetenz, was die KI-Prompts anbelangt, brauchen.[15]

Zur sprachlichen Gestaltung von Prompts gehören auch die Regeln, Normen und Realisierungen. Hierzu ist zu erwähnen, dass die Prompts durch eine klare und präzise Sprache gekennzeichnet werden sollten, und dass sie mit Verben in Imperativ und mit Verzicht auf die Höflichkeitsmarken, wie *bitte* und *danke*[16] formuliert sein sollten. Dass man sich so kurz wie möglich und so lang wie nötig beim Verfassen der KI-Prompts halten sollte, beeinflusst auch den Energie-Verbrauch solcher Modelle: je mehr Wörter (engl. *Token*) sie bearbeiten sollten, desto mehr Energie sie verbrauchen. Auch aus diesem Grund ist es sinnvoll, die sprachliche Gestaltung von KI-Prompts in der Fremdsprache zu thematisieren, und den DaF-Lernenden helfen, durch kurze und klare Anweisungen zum gewünschten Ergebnis zu kommen.

Adamzik (2004, S. 115) nutzt den Begriff *Textfunktion* als Bezeichnung für die „im Text mit bestimmten, konventionell geltenden, d.h. in der Kommunikationsgemeinschaft verbindlich festgelegten Mitteln ausgedrückte Kommunikationsabsicht des Emittenten. Es

[14] Microsoft. (2025). Copilot [Large language model]. Microsoft. https://copilot.microsoft.com, abgerufen am 15.09.2025

[15] Vgl. Developing skills in prompt engineering improves students' abilities to transform AI from a "mere repository of information into an interactive tool that stimulates deeper learning and understanding" (Walter, 2024, S. 14).

[16] Vgl. dazu die zahlreichen Beiträge in der Presse und nicht nur.

handelt sich also um die Absicht des Emittenten, die der Rezipient erkennen soll.“ Während im Rahmen der Strategien zur grundlegenden Steuerung der KI die Sprache eher eine darstellende Funktion hat und der Informationsvermittlung dient, kommen die Appellfunktion und die Ausdrucksfunktion in den kreativ-logischen und iterativ-didaktischen Strategien vor. Hierzu finde ich es gewinnbringend die Lernenden darüber bewusst zu machen und zur Reflexion zu bringen, was ihr Ziel bei der Kommunikation mit der großen Sprachmodellen ist. Ob Informationen recherchiert und zusammengefasst werden können oder ob neue Perspektiven und Einsichten gewonnen werden sollten, macht es bezüglich der sprachlichen Funktion den Unterschied.

Das *Chain-of-Thought (CoT) Prompting* (de. *Schritt für Schritt-Denken*) kann für unterschiedliche Lernkontexte, in denen die Argumentation und die Begründung eine wichtige Rolle spielen, verwendet werden. Im Rahmen des Wirtschaftsdeutschunterrichts kann das Lehren und Lernen dieser Prompting-Strategie in unterschiedlichen Kommunikationskontexten, die spezifisch für den wirtschaftlichen Bereich, wie z.B. Verhandlungen, Kundenkommunikation, Projektentwicklung und Durchführung vorteilshaft sein. Die Inhalte von Prompts können beliebig variiert werden, je nach Interessen der Lernenden und das verfolgte Ziel. Was die Prompts zu fachspezifischen Aufgaben anbelangt, muss darauf aufmerksam gemacht werden, mit welcher Definition eines Fachkonzeptes operiert wird. Es ist zunächst von Bedeutung, für wen und in welchen Kontext die Chatbots-Antworten liefert.

Zuletzt geht es um das Merkmal *situativer Kontext* und diesbezüglich muss hervorgebracht werden, dass die diese Sprachmodelle bekanntlich viele Perspektiven und Rollen einnehmen können. Da kann der Raum-Zeit-Rahmen sowohl für Emittenten als auch für Rezipienten beliebig variiert werden. Als Beispiel soll hier die Strategie Rollensimulation und CoT eingeführt werden. Mit dieser Strategie können Aufgaben für spezifische Kontexte sprachlich bearbeitet werden, wobei es wichtig für den DaF-Lernenden den eigenen Schreib- und Kommunikationsstil in der Fremdsprache zu reflektieren. Sei hier bildhaft auf die fünf Stile, die Adamzik, 2004 listet, hingewiesen: „1. (Stil der) öffentliche(n) Rede; 2. (Stil der) Wissenschaft; 3. (Stil der) Presse und Publizistik;4. (Stil der) Alltagsrede; 5. (Stil der) schöne(n) Literatur.“ (Adamzik, 2004, S. 69). Die Sensibilisierung für die unterschiedlichen Sprachregister und das Code-Switching, nicht nur innerhalb einer Sprache, sondern auch von einer Sprache zur anderen sollen als Lernziel besonders im Unterricht betonnt werden. Dabei können gezielt auch kulturelle Unterschiede im Rahmen von Landeskunde-Projekten thematisiert werden, in Betracht ziehend, dass die meistverwendeten Modelle, nämlich ChatGPT und Copilot mit englischen Texten / Daten trainiert wurden und beim Übertragen in andere Sprachen, nämlich Deutsch auf die Businessknigge, kulturellen Standards nicht achten, sondern „wortwörtlich“ hin und her zwischen Sprachen übertragen.

Bei den komplexeren Prompts gewinnen auch die „textzentrierte Kriterien“ an Bedeutung, und zwar die „Kohäsion (also die grammatisch lexikalischen Verknüpfungen

auf der Oberflächenstruktur) und die Kohärenz (den inhaltlichen Zusammenhang betreffende Relationen) (Schwarz-Friesel & Consten, 2014, S. 19) an Bedeutung. Das Lehren und Lernen dieser Vertextung-Grundsätze stellt ein wesentlicher Teil der Schreibkompetenz, die nun um die Textsorte der KI-Prompt erweitert werden kann.

Zusammenfassend plädiere ich dafür, dass der KI-Prompt als eine gesonderte Textsorte der Sachtexte im Unterricht zu behandeln. Ich sehe dabei den größten Vorteil darin, dass den Lernenden beigebracht wird, wie sie ihre Lernprozesse durch Personalisierung optimieren und effizienter machen können. In diesem Sinne stimme ich Walter (2024, S.4) zu:

> One of the most compelling prospects offered by AI in education is the personalization of learning experiences. AI's capacity to tailor educational content to the unique learning styles and needs of each student holds the potential for a more engaging and effective educational journey (Walter, 2024, S. 24).

Trotz offensichtlicher Schwachstellen von KI[17] was das Erkennen des Sprachniveaus eines fremdsprachigen Benutzers der deutschen Version anbelangt, bin ich der Meinung, dass mit Chatbots im DaF-Unterricht gewinnbringend gearbeitet werden kann, indem je nach Sprachniveau Sprachbausteine für unterschiedliche Prompting-Strategien zusammengestellt werden.

4. Zusammenfassende Bemerkungen

Das Zitat von Seneca „Wer den Hafen nicht kennt, in den er segen will, für den ist kein Wind der richtige" trifft meiner Meinung nach genau auf das Hauptziel bei der Behandlung der KI-Prompts im Rahmen des DaF-Unterrichts zu. Indem die Lernenden im Rahmen des DaF-Unterrichts auf die sprachlichen Merkmale von KI-Prompts nicht nur als Texte sondern auch als Textsorte aufmerksam gemacht werden und je nach Sprachniveau Lieblingssprachbausteine gesammelt und gefestigt werden, entwickeln die Lernenden nicht nur ihre sprachliche Kompetenz in der Fremdsprache, sondern auch ihre digitale Kompetenz, indem sie lernen, wie diese sprachlichen Modelle funktionieren, welche Merkmale den sprachlichen Input als Systemsteuerung regieren. Indem sie diese Merkmale kennen, können sie bei der Kommunikation mit KI gezielt darauf achten und so effizienter damit arbeiten.

[17] Vgl. dazu „Die einschränkende Herausforderung beim Einsatz von Chatbots im Sprachunterricht besteht darin, dass die nach klar definierten Szenarien mit vorhersehbaren Dialogen arbeiten und auf einfache Schlüsselwörter reagieren, ohne dabei die grammatikalische oder pragmatische Korrektheit der Spracheingabe beurteilen zu können Pokrivcakova (2019, S. 142).

Die vorliegende Arbeit setzte sich zum Ziel, KI-Prompts aus einer textlinguistischen Perspektive für den DaF-Unterricht zu analysieren und Schlussfolgerungen für die Praxis des DaF-Unterrichts an einer Hochschule zu ziehen. Die Anweisungen, die man im Rahmen der Kommunikation mit der künstlichen Intelligenz verfasst, weisen die Merkmale von Texten auf und können als eine Textsorte eingestuft werden. Die Arbeit versteht sich al sein Plädoyer zur Erweiterung der im Rahmen des DaF-Unterrichts behandelten Textsorten um eine weitere: der KI-Prompt.

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Teaching Cognate Languages in Secondary Education: A Case Study on a Norwegian Language Summer School

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This paper examines the pedagogical potential of artificial intelligence (AI) in teaching cognate foreign languages, focusing on the acquisition of Norwegian by secondary-level learners (ages 11–16) who already possess a solid foundation in English (intermediate to upper-intermediate – B1/B2) and an elementary to intermediate level (A2–B1). Based on classroom insights from a 2021 Norwegian summer school, the paper explores how AI can enhance cognate-based language instruction, support cross-linguistic transfer, and deepen intercultural competence in both lower and upper secondary education.

Cognate languages such as English, German, and Norwegian and other Germanic languages share numerous lexical, syntactic, and morphological similarities. From a didactic standpoint, these connections offer an almost ideal entry point into the acquisition of a third foreign language. AI tools can assist learners in making meaningful linguistic comparisons, promoting noticing, pattern recognition, and language awareness. It is recommendable, based on direct teaching experience, to use AI as a reflective learning support that helps learners uncover connections between related lexical items (cognates) and shared or divergent grammatical structures across the three languages.

This paper is grounded in principles from plurilingual education, contrastive didactics, and task-based language teaching (TBLT). It aligns with CEFR descriptors related to language awareness, plurilingual competence, and intercultural communicative competence (ICC). It promotes guided AI use to support both receptive and productive skills, as well as critical cultural engagement. Classroom-recommended strategies include: using ChatGPT to generate contrastive dialogues or prompts in English, German, and Norwegian that highlight structural transfer points; employing DeepL or Reverso to conduct parallel translation tasks, helping students identify true and false cognates, word order patterns, and sentence structure rules; creating AI-assisted lexical comparison grids, where learners sort AI-suggested vocabulary into cognate and non-cognate categories and assigning reflection tasks where students analyze how AI tools reflect cultural perspectives across the three linguistic contexts.

The article also discusses how AI can support homework and autonomous learning, such as generating grammar explanation prompts in English and comparing them to AI-generated equivalents in German and Norwegian, or using conversational bots to practice oral skills with immediate lexical and syntactic feedback.

AI-mediated learning; plurilingual competence development; cross-linguistic transfer; cognate awareness; intercultural communication; artificial intelligence in language teaching.

1. Introduction

The teaching of foreign languages in secondary education is currently undergoing a significant transformation as a result of the integration of digital technologies and artificial intelligence (AI). AI-based tools have shown considerable potential to enhance language learning, particularly in contexts where learners are acquiring multiple languages from the same or related linguistic families. Cognate languages—languages that share common lexical, syntactic, and morphological features—offer a unique opportunity for leveraging cross-linguistic transfer and fostering plurilingual competence among students. In European secondary education contexts, English and German often form the foundation for learning additional languages, such as Norwegian, enabling learners to capitalize on cognate connections to accelerate acquisition and deepen linguistic awareness.

Despite growing interest in AI-assisted language instruction, research examining its practical integration in classroom settings, particularly for cognate languages, remains limited. Existing studies emphasize AI's potential in generating adaptive exercises, facilitating pattern recognition, and providing immediate feedback, yet empirical evidence from real classroom applications is scarce. This gap is particularly evident in secondary education, where learners are at a critical stage for developing both receptive and productive skills, as well as the intercultural communicative competence (ICC).

This study investigates the pedagogical potential of AI in teaching cognate foreign languages, focusing on the acquisition of Norwegian by secondary-level learners aged 11–16, who possess intermediate proficiency in English (B1) and elementary to beginner-level German (A1–A2). Drawing on insights from a 2021 Norwegian summer school, the research examines how AI can support cross-linguistic transfer, enhance learner awareness of cognates and grammatical structures, and strengthen intercultural understanding. The study further explores practical strategies for integrating AI into classroom activities, highlighting opportunities to augment traditional teaching methods with AI-assisted exercises.

The objectives of this study are threefold: (1) to evaluate how cognate-based instruction can be optimized through AI integration; (2) to identify specific classroom applications that enhance linguistic and cultural competence; and (3) to discuss potential limitations and propose strategies for mitigating challenges associated with AI use in secondary education. By addressing these objectives, this study contributes to the growing discourse on AI-assisted language education and offers practical insights for teachers and researchers seeking to implement technology-assisted plurilingual instruction.

2. Theoretical Framework

2.1. Plurilingual Education Principles

The concept of plurilingual education, as defined by the Council of Europe (2001), emphasizes the integration of learners' linguistic repertoires rather than treating languages

as isolated systems. This approach encourages learners to mobilize their existing linguistic and cultural knowledge when acquiring new languages, developing what the *Common European Framework of Reference for Languages (CEFR)* defines as *plurilingual and pluricultural competence* (Council of Europe, 2001, pp. 24–27). The theoretical foundation of this study aligns with this perspective, framing the use of AI tools as an instrument that can enhance learners' awareness of cross-linguistic similarities and differences.

Beacco et al. (2016) argue that plurilingual education fosters the capacity to navigate and mediate between linguistic systems, reinforcing intercultural communication and reflection. Similarly, van Lier (1996) emphasizes that language learning should not only focus on linguistic accuracy but also on awareness and authenticity in interaction. Within this paradigm, the integration of artificial intelligence can be seen as a natural extension of a pedagogical shift toward learner autonomy and metalinguistic reflection (Benson, 2011, pp. 58–60).

2.2 Contrastive Didactics and Cross-Linguistic Influence

Contrastive didactics provides a valuable framework for understanding how learners transfer knowledge between related languages. Research on cross-linguistic influence (Ringbom, 2007, pp. 88–90) demonstrates that cognate recognition and structural similarities between related languages, such as English, German, and Norwegian, facilitate positive transfer and reduce cognitive load in the acquisition of additional languages. Viberg (2009) and Ringbom (2007) both highlight the lexical and semantic advantages that learners gain when identifying and exploiting interlingual similarities, particularly in the early stages of third-language (L3) acquisition.

From a psycholinguistic standpoint, these similarities allow learners to build on their existing mental lexicon, accelerating comprehension and production. Schmidt's (1990) noticing hypothesis further supports the idea that conscious attention to form is crucial in developing interlanguage competence. The role of AI tools—such as ChatGPT, DeepL, and Reverso—is particularly relevant here, as they can generate contrastive examples, highlight morphological and syntactic correspondences, and guide learners toward noticing relevant patterns across cognate languages.

2.3 Cognitive Load and Task Design

Within cognitive learning theory, Sweller (1988) explains that excessive cognitive load can impede learning by overburdening working memory. However, when tasks are structured around familiar linguistic patterns, learners can allocate more mental resources to acquiring new structures rather than decoding form. Skehan (1998, pp. 103–104) supports this view, proposing that task complexity and linguistic familiarity should be balanced to optimize learning efficiency.

The author argues that AI can assist teachers in this balancing act by automatically generating graded tasks based on learners' proficiency levels, a principle consistent with

the CEFR's can-do descriptors (Council of Europe, 2001, p. 108). For example, ChatGPT or Praktika.ai can be used to produce assisted dialogues, where learners compare equivalent structures in English, German, and Norwegian, thus reducing extraneous load while increasing engagement.

2.4 Task-Based Language Teaching (TBLT) and AI Mediation

Task-Based Language Teaching (TBLT) has long been recognized as an effective approach to developing communicative competence by integrating real-world tasks and learner interaction (Cameron, 2001, pp. 66–67; Lightbown & Spada, 2013, p. 93). AI-enhanced TBLT environments allow for dynamic adaptation of tasks, immediate feedback, and increased learner agency. For instance, Godwin-Jones (2023) notes that AI-driven platforms can personalize task input, support pronunciation and fluency monitoring, and simulate authentic communication scenarios.

The integration of AI into TBLT also aligns with principles of autonomous learning (Benson, 2011) and reflective noticing (Schmidt, 1990). Through guided prompts or AI-generated scenarios, learners can explore linguistic similarities across cognate languages, fostering both metalinguistic awareness and intercultural sensitivity. Such AI-supported mediation can transform contrastive tasks—traditionally static into adaptive, interactive, and context-sensitive learning experiences.

2.5. AI and the Intercultural Communicative Competence

Intercultural communicative competence (ICC) forms a central pillar of plurilingual education. According to Beacco et al. (2016), ICC involves the ability to interpret, relate, and mediate cultural meanings across languages. In the context of AI-assisted language learning, platforms such as Praktika.ai now integrate cultural simulation features that expose learners to pragmatically and culturally varied dialogue situations (Praktika.ai, 2025). This supports the development of intercultural awareness through personalized, scenario-based practice.

At the same time, ethical considerations, such as algorithmic bias and data privacy, remain crucial in ensuring that AI-driven education supports inclusive and equitable learning environments (Noble, 2018, pp. 77–79; Council of Europe, 2023; European Commission, 2016). The author thus advocates for a reflective and critical approach to AI use, where technology serves as a facilitator of linguistic and cultural insight and not merely as an efficiency tool.

3. Case Study: The "Flink i norsk" Summer School (Iași, 2021)

3.1 Context and Participant Profile

The case study is based on a two-week summer school titled *Flink i norsk*, organized in Iași, Romania, in July 2021. The program introduced Norwegian as a new foreign

language to secondary school learners aged 11–16, most of whom already possessed a solid foundation in English and varying degrees of competence in German. The class size fluctuated between eight and ten participants, depending on attendance.

Students' proficiency levels were classified according to CEFR descriptors (Council of Europe, 2001, pp. 24–27): English ranged from B1 to B2 (intermediate to upper-intermediate), while German ranged from A1 to A2 or beginner levels. Norwegian was introduced as a third language (L3), making the course an ideal setting to explore cognate-based transfer within the Germanic language family.

3.2 Instructional Design and Rationale

The activities implemented in the 2021 program were conducted without the direct assistance of AI technologies. However, their design anticipated principles that could later be amplified by AI-supported scaffolding, as theorized by Levy and Stockwell (2006) and Chapelle (2001). The author designed the course to promote cross-linguistic noticing and plurilingual awareness, focusing on lexical and structural similarities between English, German, and Norwegian (Ringbom, 2007, pp. 88–89).

Tasks combined visual, auditory, and kinesthetic elements to support multimodal engagement (Cameron, 2001, pp. 66–67). According to TBLT principles (Lightbown & Spada, 2013), each activity aimed to activate communicative competence through meaning-oriented interaction rather than mechanical drilling.

3.3 Examples of Classroom Activities

Three main task types were employed throughout the summer school:

1. **Cognate Identification Games:** Using platforms such as Baamboozle, Kahoot and Quizizz, learners identified correct Norwegian cognates based on English or German prompts. For example, when presented with a German or English word, students selected its Norwegian equivalent from multiple-choice options. These tasks promoted awareness of lexical families and highlighted both "true" and "false" cognates (Viberg, 2009).
2. **Gap-Filling Exercises:** Learners completed short sentences in Norwegian using cognate cues provided in English. Sometimes, the English word was placed in parentheses, and students were asked to recall or infer the Norwegian form. This technique supported noticing (Schmidt, 1990) and reinforced form-meaning mapping, contributing to a deeper understanding of morphological patterns.
3. **Movement and Music-Based Cognate Sorting:** In a more kinesthetic task, students physically responded—standing up, sitting down, or moving—when encountering "intruder" words from the third language in a sequence of bilingual cognates. For example, in a string of English-German pairs, a

Norwegian cognate might appear as an "intruder." These activities encouraged quick lexical recognition, pattern awareness, and playful engagement.

3.4 Observations and Learner Outcomes

Qualitative observations and short reflective discussions revealed several recurring outcomes. Students recognized cognates more rapidly as the course progressed and became increasingly aware of grammatical differences among the three languages. Learners also displayed greater confidence in oral expression, even when their grammatical control remained limited—confirming previous findings that lexical familiarity accelerates communicative readiness (Ringbom, 2007; Skehan, 1998).

The results indicate that cognate-based instruction enhances both receptive and productive skills, particularly when reinforced through cross-linguistic comparison. As Sweller (1988) and Skehan (1998) suggest, task familiarity can reduce the cognitive load and promote learning more efficiently. These effects were clearly observable in the students' growing ability to hypothesize and self-correct linguistic forms across the three languages.

3.5 Potential AI Enhancement

Although the original summer school activities were not AI-assisted, their structure lends itself naturally to AI integration. Tools such as ChatGPT, DeepL, and Praktika.ai could be used to expand and individualize similar learning tasks. ChatGPT, for instance, can generate contrastive dialogues or translation prompts across English, German, and Norwegian, enabling learners to explore morphological and syntactic parallels.

DeepL or Reverso could support reflective translation exercises, helping students identify true and false cognates and discover cross-linguistic regularities (Moorkens, 2022).

Furthermore, Praktika.ai offers AI-driven speech feedback and cultural simulation features that could extend learners' exposure to authentic pronunciation and intercultural contexts (Praktika.ai, 2025). Through these tools, AI would not replace instruction but rather enrich it—providing personalized feedback, adaptive scaffolding, and increased learner autonomy (Godwin-Jones, 2023).

3.6 Implications

The *Flink i norsk* case study illustrates that cognate-based instruction is particularly effective when learners have existing proficiency in related languages. The use of AI can strengthen this effect by providing immediate corrective input and expanded opportunities for autonomous practice. The author argues that integrating AI tools within such cognate frameworks can promote *plurilingual awareness* and *metacognitive reflection* (Benson, 2011; Beacco et al., 2016), developing both linguistic and intercultural competence.

4. Pedagogical Applications

4.1. AI as a Reflective Learning Support

The pedagogical rationale for integrating artificial intelligence (AI) into the teaching of cognate languages lies in its capacity to enhance noticing, pattern recognition, and language awareness. Schmidt's (1990) noticing hypothesis underscores that learners must consciously attend to linguistic forms in order to internalize them. In the context of teaching cognate languages such as English, German, and Norwegian, AI tools can serve as reflective mediators, helping students recognize systematic relationships between lexical and grammatical patterns (Ringbom, 2007; Viberg, 2009).

AI-driven tools such as ChatGPT, DeepL, Reverso, and Praktika.ai can generate dynamic linguistic comparisons, suggest contrastive examples, and support metalinguistic reflection. For example, ChatGPT can prompt learners with tri-lingual sentence sets highlighting similarities and divergences in word order or morphology (Godwin-Jones, 2023). DeepL or Reverso can provide aligned translations that learners analyze collaboratively, distinguishing between true and false cognates, semantic shifts and idiomatic divergences (Moorkens, 2022).

These tools thus promote plurilingual awareness, a key objective in the Council of Europe's framework (Beacco et al., 2016)—while fostering learner autonomy through guided discovery and self-regulated exploration (Benson, 2011).

4.2 AI-Assisted Task Design

AI-based systems can substantially enrich *Task-Based Language Teaching (TBLT)* environments by offering adaptive and personalized scaffolding. In alignment with Levy and Stockwell's (2006) view of computer-assisted language learning as a continuum between automation and interaction, AI can serve both formative and creative functions.

The author recommends using ChatGPT to automatically generate contrastive dialogues across English, German, and Norwegian that emphasize structural transfer points. For example, students can be prompted to complete or rephrase sentences produced by AI, focusing on syntax differences (e.g., verb position, definite article usage). According to Skehan (1998, pp. 103–104), such contrastive, cognitively challenging tasks enhance linguistic complexity and depth of processing while maintaining communicative purpose.

Similarly, DeepL and Reverso can be used for parallel translation tasks, enabling students to align and compare sentences across the three languages. This facilitates awareness of interlingual variation while keeping cognitive load within manageable limits (Sweller, 1988). AI feedback helps identify systematic errors and provides explanations in accessible language, thus supporting differentiated learning (Chapelle, 2001).

4.3. Lexical Comparison and Categorization Tasks

AI can also assist in building AI-generated lexical comparison grids, where learners are presented with lists of potential cognates and asked to categorize them as true cognates, false cognates, or non-cognates. ChatGPT can generate such lists automatically, including distractors and contextual examples. Learners then reflect on observed patterns, discussing which features—orthographic, phonological, or semantic—indicate cognate status (Ringbom, 2007).

These reflective categorization tasks can be gamified through quiz-style interfaces like Kahoot or Baamboozle, maintaining the original classroom model while adding real-time AI adaptation. When implemented with Praktika.ai or similar voice-interactive systems, the same tasks can also train pronunciation and receptive listening skills (Praktika.ai, 2025).

4.4. Homework and Autonomous Learning with AI

AI tools can extend classroom learning into the home environment, promoting learner autonomy (Benson, 2011). For example, students can use ChatGPT to generate personalized grammar explanations in English and then compare them to Norwegian or German equivalents produced by AI. Such exercises deepen metalinguistic awareness and reinforce the contrastive analysis approach.

Praktika.ai's conversational mode enables oral skill development outside class, allowing students to practice target language dialogues while receiving immediate feedback on pronunciation, lexical choice, and grammatical accuracy. This aligns with the learner autonomy and interactional authenticity principles highlighted by van Lier (1996).

In addition, AI systems can offer adaptive feedback loops, tailoring corrective input to each learner's pace and proficiency. Godwin-Jones (2023) emphasizes that this adaptability makes AI particularly valuable in mixed-level classrooms, where students' language profiles differ across multiple foreign languages.

4.5. Intercultural and Ethical Dimensions

In addition to linguistic benefits, AI tools can facilitate the development of *intercultural communicative competence (ICC)* by embedding cultural context into language practice. Through scenario-based simulations in Praktika.ai or AI-generated dialogues in ChatGPT, learners can explore social norms, politeness conventions, and idiomatic expressions across English-, German-, and Norwegian-speaking cultures (Beacco et al., 2016).

However, as Noble (2018, pp. 77–79) and the Council of Europe (2023) caution, educators must ensure that such AI-mediated experiences are implemented ethically, avoiding biases and preserving learner privacy in compliance with the General Data Protection Regulation (European Commission, 2016). The pedagogical model should therefore balance innovation with critical digital literacy, ensuring learners not only use AI effectively but also understand its implications.

5. Challenges and Limitations

5.1. Technological and Infrastructure Barriers

Although the pedagogical benefits of AI integration are clear, practical implementation in schools often faces significant technological and infrastructural constraints. As van der Zanden (2024) highlights, disparities in access to digital tools, internet connectivity, and institutional resources can limit the scalability of AI-enhanced language instruction. In secondary education contexts, particularly in less digitally advanced regions, teachers may lack both the hardware and training necessary to integrate AI meaningfully into daily instruction.

This "digital divide" may exacerbate existing inequalities between learners who have regular access to AI platforms (e.g., ChatGPT, DeepL, Praktika.ai) and those who do not. The Council of Europe (2023) underscores the need for inclusive digital policies that guarantee equitable access to educational technology, emphasizing that innovation should not deepen existing socio-economic gaps.

5.2. Teacher Preparedness and Pedagogical Training

One major limitation lies in teachers' readiness to use AI pedagogically rather than merely as a technical aid. Many educators remain uncertain about how to design AI-assisted tasks that align with curriculum objectives and maintain cognitive depth. Levy and Stockwell (2006) point out that the pedagogical value of technology depends less on the tool itself than on its integration into a coherent learning design. Furthermore, as Chapelle (2001) and Reinders and White (2023) emphasize, successful AI-enhanced instruction requires explicit teacher training in computational literacy, data interpretation, and ethical use. Without this preparation, teachers risk delegating too much of the learning process to AI, potentially reducing learners' metacognitive engagement.

Professional development programs are therefore essential to ensure teachers can interpret AI-generated feedback, critically evaluate output accuracy, and guide students toward reflective learning (Godwin-Jones, 2023).

5.3. Overreliance and Cognitive Implications

Another pedagogical challenge involves learners' possible overreliance on AI-generated answers. When learners consistently depend on AI for translation, grammar correction, or lexical choice, they may bypass essential processes of cognitive struggle and hypothesis testing (Skehan, 1998; Sweller, 1988). This could limit the development of procedural knowledge and long-term retention.

Benson (2011) warns that autonomy does not imply independence from guidance; instead, it requires a balance between learner initiative and teacher mediation. In AI-assisted learning, this balance must be carefully maintained to ensure that learners use AI as a reflective companion rather than a replacement for cognitive engagement.

AI should therefore be framed as a metacognitive tool—an assistant that prompts reflection and pattern recognition—rather than a direct source of linguistic truth. Teachers

must design activities where AI output becomes material for analysis and discussion, not passive consumption.

5.4. Data Ethics, Privacy, and Algorithmic Bias

Ethical concerns form another major limitation of AI in education. According to Noble (2018), algorithms are not neutral; they reflect the cultural and linguistic biases embedded in their training data. In language learning, this may result in the reinforcement of dominant cultural norms or the marginalization of minority language varieties.

Institutions must also comply with the *General Data Protection Regulation (GDPR)* (European Commission, 2016), which governs the collection and storage of personal data, including voice and text input in AI platforms. The Council of Europe (2023) advocates for transparent data management, particularly in educational contexts involving minors.

In addition, as Godwin-Jones (2023) and Moorkens (2022) observe, AI systems such as DeepL and Reverso often rely on large-scale corpora whose content may not always be pedagogically or culturally appropriate. Teachers must therefore curate and contextualize AI output to prevent uncritical reproduction of biased or inaccurate material.

5.5. Pedagogical Constraints and Institutional Resistance

From an institutional perspective, curriculum alignment and administrative approval can pose additional challenges. Traditional curricula, particularly in public education systems, may not easily accommodate experimental AI-enhanced modules. As Skehan (1998) and Cameron (2001) note, pedagogical innovation often requires systemic support, including curriculum flexibility, access to training resources, and continuous assessment tools.

Resistance may also come from educators unfamiliar with AI or concerned about its potential to undermine their role. Addressing these concerns requires clear communication of AI's purpose as a supportive, not substitutive, component of instruction—an idea echoed by Beacco et al. (2016) in their emphasis on the teacher's central mediating role in plurilingual education.

5.6. Sustainability and Long-Term Integration

Finally, long-term sustainability remains a key limitation. AI platforms evolve rapidly, and maintaining consistent pedagogical frameworks requires ongoing adaptation. Teachers and institutions must anticipate version updates, subscription costs, and evolving privacy policies. As Levy and Stockwell (2006) note, CALL (Computer-Assisted Language Learning) initiatives frequently fail when they depend on external funding or proprietary systems that become obsolete.

A sustainable model would therefore emphasize open-access AI tools, interdisciplinary collaboration, and continuous teacher training. As Reinders and White (2023) argue, sustainable integration depends on cultivating "AI literacy" among both teachers and learners—an understanding of how AI functions, where it can fail, and how it can be used ethically and creatively.

6. Conclusion

AI-based tools can strengthen the pedagogical potential of cognate language instruction by uniting reflective, communicative, and intercultural dimensions. The challenge lies not in the technology itself, but in how it is pedagogically framed and ethically integrated into plurilingual learning environments. While AI offers transformative potential for cognate-based language learning, its implementation must address practical, cognitive, ethical, and institutional challenges. The author argues for a model that emphasizes teacher mediation, learner reflection, and ethical responsibility, ensuring that AI remains a tool for enhancement rather than substitution in language learning.

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Artificial Intelligence in Inclusive Education: A Review of Opportunities and Challenges for Neurodivergent Learners

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The integration of Artificial Intelligence (AI) into education has opened new avenues for supporting students with neurodevelopmental disabilities (NDDs), including autism spectrum disorder (ASD), attention-deficit and hyperactivity disorder (ADHD), and dyslexia. This review examines current AI applications designed to enhance screening, learning, assessment, and behavioral support for students with NDDs, drawing on interdisciplinary research from education, neuroscience, and computer science. The paper examines how assistive technologies and AI-powered tools such as intelligent tutoring systems (ITS), speech and language technologies, chatbots, and gamified tools can cater to the diverse needs of neurodivergent students. While AI shows promise in creating more inclusive and adaptive learning environments, the review also highlights critical challenges, including ethical concerns, data privacy, algorithm bias, and unequal access to technology. By synthesizing findings from the current literature, this article provides a comprehensive overview of the opportunities and limitations of using AI in inclusive education.

AI; neurodiversity; inclusive education; ASD; ADHD; dyslexia.

1. Introduction

The concept of artificial intelligence (AI) has long been the subject of debate among scholars, researchers, and practitioners. As both a scientific field and a practical tool, AI resists simple categorization because its scope and applications continue to expand rapidly. Establishing a clear definition is essential for understanding its role in education and other domains, yet the very nature of AI makes such a definition elusive. As AI technologies

become increasingly embedded in everyday tools, they often lose the explicit label "AI" and are instead regarded as conventional software or algorithms. This shifting boundary complicates a fixed definition. Additionally, AI encompasses contributions from diverse fields—including computer science, neuroscience, psychology, philosophy, linguistics, anthropology, and biology—each adding unique perspectives and terminology (Luckin et al., 2016).

Holmes et al. (2019) state that some researchers prefer the term augmented intelligence, which frames the human brain as the primary source of intelligence and views computers as sophisticated tools that enhance human cognitive abilities, especially by handling tasks that humans find difficult and time-consuming, such as identifying patterns in large datasets. They maintain that although this appellation may be more accurate or useful, the term artificial intelligence remains dominant in popular usage and discourse. In this paper, both the terms artificial intelligence and augmented intelligence are used interchangeably to refer to computer systems designed to interact with the environment through human-like capabilities such as visual perception and speech recognition, and to exhibit intelligent behaviors, including evaluating information, problem-solving, and making decisions aimed at achieving specific goals.

With the use of AI spreading across many fields, education is no exception. In fact, Artificial Intelligence in Education (AIED) has been the subject of research for over five decades, but recent years have seen a surge in investment and innovation. Tech giants like Amazon, Google, and Facebook have joined established AIED edtech companies such as Knewton and Carnegie Learning, channeling millions into AI-driven educational tools. Initiatives like the $15 million Global Learning XPrize have further promoted the development of technologies that enable learners to guide their own education. Simultaneously, AI is gaining ground in mainstream schooling not only as a tool for online tutoring and teacher training, but also as a subject within the curriculum itself. But despite the exponential growth of the AIED market, the application of AI in educational settings remains relatively unfamiliar to the wider public. The integration of AI raises significant implications for educational practices, including shifts in teacher roles, student agency, data usage, and broader ethical and social impacts (Holmes et al., 2019).

Luckin et al. (2016) proclaim that at its core, Artificial Intelligence in Education (AIEd) aims to make educational, psychological, and social knowledge computationally explicit, that is to say, transforming learning processes that are often implicit into structured, analyzable data. In other words, beyond powering smart educational technologies, AIEd serves as a tool for uncovering the complex, often hidden mechanisms of learning. It enables fine-grained insights into how learning unfolds, including the influence of socio-economic, physical, and technological factors. These insights can inform both the design of future AI-driven tools and non-technological teaching strategies, such as helping educators identify learning steps or the typical misconceptions that arise when trying to understand a complex concept.

Luckin et al. (2016) explain how AIEd systems rely on two key components: (i) knowledge about the world, which includes facts, concepts, skills, and educational content, and (ii) algorithms that use this knowledge to make intelligent, goal-oriented decisions that mimic human cognitive processes. This knowledge is organized into three central models within AIED systems:

The Domain Model: Encapsulates the subject matter or content knowledge the system is intended to teach. It includes the structure of concepts, their relationships, and the correct solutions to problems within a particular discipline.

The Pedagogical Model: Outlines strategies for effective teaching and learning. It determines how the system decides what to present, how to present it, and how to respond to learner errors—much like a human teacher adapting their instruction based on student needs.

The Learner Model: Represents the system's dynamic understanding of the individual learner. It includes data on the student's current knowledge, learning progress, behavior, preferences, and potentially even emotional states. The learner model allows the system to personalize content and adapt instructional strategies in real time.

The framework outlined by Luckin et al. (2016) holds considerable promise for supporting neurodivergent learners in inclusive classrooms as well as in the comfort of their homes. These three models allow AIEd systems to complement human instruction, enhancing engagement, accessibility, and equitable learning opportunities. When implemented simultaneously in a single system, they could even simulate the roles of a competent human teacher—delivering the right content, in the right way, at the right time, tailored to the needs of each learner—hence potentially limiting, or even obsoleting, the need for human instruction.

According to UNICEF (2021), nearly 240 million children worldwide live with some form of disability, a figure that reflects a broader and more inclusive understanding of functional domains, including psychosocial well-being. While most experience difficulties in only one domain, psychosocial challenges are the most prevalent across age groups. Children with disabilities face significant disadvantages compared to their peers, particularly in education. Despite the global commitment to inclusive education under Sustainable Development Goal 4, especially targets 4.5 and 4.a that emphasize equity for children with disabilities, data revealed that students with disabilities are more likely to be out of school—especially those with severe disabilities—and those who do attend are less likely to acquire foundational reading and numeracy skills. Limited access to learning opportunities and resources at home, together with other barriers such as stigma, untrained teachers, and inaccessible infrastructure further compound these disparities. This persistent exclusion not only limits their academic opportunities but also undermines their overall well-being and future prospects.

Recent developments in artificial intelligence (AI) have created new opportunities to support neurodivergent students within educational environments. AI-powered tools—

such as personalized learning systems, speech and language technologies, chatbots, and gamified applications—can cater to the diverse cognitive and learning needs of these students, promoting more inclusive and adaptive learning environments. However, alongside these opportunities, AI introduces challenges related to ethics, data privacy, algorithmic bias, and unequal access to technology. Guided by the following research questions—What are the main applications of AI for supporting neurodivergent learners, what opportunities do these tools present for inclusive education, and what challenges and risks accompany their use?—this review synthesizes current research to provide a comprehensive overview of both the potential and limitations of AI in inclusive education, particularly for students with dyslexia, ASD, and ADHD.

2. Understanding Neurodivergent Learners and Their Educational Support

The concept of neurodiversity, often attributed to Judy Singer in 1998—though some argue it did not originate from a single author but rather emerged collectively in the late 1990s through activists with ASD, online communities, and later the writings of Singer and journalist Harvey Blume (Botha et al., 2024)—is less a clinical term than a political and social one. Rooted in the disability rights and civil rights movements, it asserts that neurological differences such as ASD, ADHD, dyslexia, and Tourette's syndrome should be recognized as natural forms of human variation, deserving the same respect and inclusion as categories like race, gender, or ethnicity. Much like biodiversity strengthens ecosystems, neurodiversity is framed as vital to the resilience and creativity of human societies. The movement challenges deficit-based views by emphasizing rights, identity, and the value of neurological variation, extending the social model of disability into the realm of cognitive and perceptual difference (McGee, 2012).

This paradigm underscores that these variations represent natural differences in human cognition and information processing rather than diseases that need curing. This perspective highlights the value of diverse cognitive styles, recognizing that individuals may have unique strengths, talents, and ways of learning, while also acknowledging the support they may require to thrive in social, educational, and occupational contexts (Singer, 2016). By reframing cognitive differences as part of human diversity rather than deficits, the neurodiversity paradigm advocates for inclusive practices, personalized learning, and societal accommodations that allow neurodivergent individuals to reach their full potential. While the neurodiversity paradigm has gained strong traction in education, psychology, and advocacy, there are also critics and counter-arguments. Critics of the neurodiversity paradigm do not necessarily dismiss the importance of acceptance or dignity. Instead, they call for a balanced approach that recognizes the legitimacy of neurodivergent experiences and strengths while also acknowledging the lived realities and support needs of those with more complex challenges. They caution against oversimplified narratives that may unintentionally sideline vulnerable populations (Russel, 2019).

In this article, the term neurodiversity is employed as an umbrella construct encompassing a range of neurological and cognitive differences, including ASD, ADHD, dyslexia, and other specific learning disorders. Its use is neutral and deliberately disassociated from any negative connotation.

2.1. ASD, ADHD, and Dyslexia: Definitions and Educational Implications

Specific Learning Disorders (SpLDs), also referred to as Specific Learning Disabilities, represent a group of persistent, lifelong neurodevelopmental conditions that affect the way individuals acquire and use key academic skills. These conditions are not indicative of low intelligence but rather stem from differences in cognitive processing that interfere with particular domains of learning, such as reading, writing, spelling, or mathematics. Beyond academic performance, SpLDs can also influence everyday functioning, including organization, memory, and time management (American Psychiatric Association, 2022). Dyslexia, dyscalculia, and dysgraphia are commonly recognized as specific learning difficulties (SpLDs), reflecting challenges in academic skills and subskills, namely, reading and spelling; numerical reasoning and calculation; and written expression, respectively (McDonough et al., 2017). Despite this recognition, debate continues over how best to classify these conditions and differentiate them from other neurodevelopmental differences.

Some educators and researchers also include conditions such as ASD and Attention Deficit Hyperactivity Disorder ADHD within the SpLD framework, while others view them as broader developmental disorders or disabilities that often present with associated learning difficulties. This ongoing discussion highlights the complexity of understanding cognitive and learning differences and underscores the importance of nuanced approaches to diagnosis, support, and inclusive educational practice (Sewell, 2022). In this paper, specific learning disabilities/disorders (SpLDs), include dyslexia, dyspraxia, dyscalculia, and dysgraphia and is used interchangeably with the term learning disability, while ASD and ADHD are treated as separate neurodevelopmental conditions that may involve associated learning challenges. The term neurodiversity is therefore used as a superordinate term to encompass both SpLDs and other neurodevelopmental differences that result in learning difficulties (e.g., ASD and ADHD), highlighting the diversity of cognitive and learning profiles in educational contexts and the need for personalised support.

2.1.1. Autism Spectrum Disorder (ASD)

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition marked by persistent deficits in social communication and the presence of restricted, repetitive behaviors and interests. The DSM-5, published in 2013, revised the diagnostic criteria for ASD from the DSM-IV, simplifying the framework from three sub-criteria (the triad) to two (the dyad) and incorporating sensory symptoms as a core feature. Key changes include

merging social and communicative impairments into a single social communication domain, while retaining restricted and repetitive behaviors as a separate criterion. The DSM-5 notes that symptoms emerge during early development, but they may not become fully apparent until social demands surpass the individual's abilities or are hidden by compensatory strategies. Compared to the DSM-IV, the updated criteria provide a more streamlined and developmentally sensitive approach, highlighting social-emotional reciprocity, nonverbal communication, relationship difficulties, and sensory reactivity as central features of ASD (American Psychiatric Association, 1994, 2013).

In DSM-5, the ASD diagnosis was redefined as a single "spectrum" to encompass previously distinct Pervasive Developmental Disorders (PDD), including autistic disorder, Asperger's disorder, childhood disintegrative disorder, and Pervasive Developmental Disorder – Not Otherwise Specified (PDD-NOS). Rett syndrome was excluded as it is now recognized as a separate neurological condition. A new diagnosis, Social (Pragmatic) Communication Disorder (SPCD), was created for individuals with social communication challenges but without restricted or repetitive behaviors. Severity level descriptors were also introduced to indicate the level of support required by individuals with ASD (Hodges et al., 2020).

The World Health Organization (WHO) estimates that ASD affects roughly 0.76% of the global population. This figure, however, represents only a small fraction—around 16%—of children worldwide (Baxter et al., 2015), highlighting both the variability in reported prevalence and the likelihood of underdiagnosis in many regions. Differences in diagnostic practices, access to healthcare, cultural perceptions of developmental differences, and availability of epidemiological data all contribute to this variation, suggesting that the true prevalence of ASD may be different than current estimates indicate (Salari et al., 2022). ASD is diagnosed more frequently in males than females, with girls often identified later. Females with ASD are more likely to present with co-occurring intellectual disability or epilepsy, while those without such impairments may remain undiagnosed due to subtler social and communication challenges. Compared to males, females may demonstrate stronger conversational reciprocity, greater ability to align verbal and nonverbal cues, and more situationally adaptive behaviors, sometimes masking autistic traits by imitating peers. Their repetitive behaviors may be less obvious, and special interests often center on socially normative themes, though pursued with unusual intensity (American Psychiatric Association, 2022).

The typical school environment can be highly stressful for students with ASD. In a survey, students with ASD highlighted five main areas of difficulty. The foremost challenge was navigating the social demands of school, including group work and coping with bullying or teasing. Managing anxiety and maintaining calm in the school environment was the second most common challenge, with classroom noise and peer interactions frequently cited as triggers. Third, students reported difficulties with executive

function (EF) skills essential for managing impulses and resisting distractions, planning, organizing assignments, participating in assessments, and completing homework, with research indicating that deficits in these skills negatively impact cognitive, social, and academic performance and tend to worsen with age. Coping with frequent transitions and changes to routines was another significant challenge, as students with ASD often rely heavily on structure and predictability. Finally, handwriting demands, including producing neat and timely written work, presented ongoing difficulties. Addressing these needs through targeted classroom support not only benefits students with autism but also enhances the learning environment for all students (Saggers, 2016).

Fleury et al. (2014) synthesize a wide body of research showing that the unique cognitive style of individuals with ASD—particularly difficulties in Theory of Mind[1] (ToM), Weak Central Coherence[2] (WCC), and Executive Functioning (EF)—plays a significant role in shaping reading outcomes. Although these students acquire reading skills through formal schooling, their rate of progress is often significantly slower than that of peers with other learning disabilities. Across studies, a consistent pattern emerges: many demonstrate relative strengths in word decoding but face persistent challenges with comprehension, which remains the central area of difficulty despite mixed findings on word-reading ability. Further evidence highlights variability in how students approach text, with high-functioning adolescents showing three distinct comprehension profiles: text-bound readers who focus only on the text without accessing the background knowledge; imaginative readers who rely on visual support, background knowledge, but tend to oversubjectify the inference, and strategic readers who apply conventional comprehension strategies but struggle to make predictions. Collectively, these findings suggest that ToM, WCC, and EF deficits influence reading comprehension in varied ways, underscoring the heterogeneity of literacy development in ASD.

Moving on from reading to writing, Fleury et al. (2014) note that students with ASD often encounter writing challenges that involve both the mechanics of handwriting and the broader demands of written expression. Several studies have shown that difficulties with fine motor skills and visual-motor speed can make handwriting slow, laborious, and sometimes illegible, often resulting in shorter writing samples. Beyond these mechanical issues, problems with perspective can limit students' ability to adjust their writing for an intended audience, while weaknesses in executive functioning make it harder to plan, organize, generate, and revise text.

Science, Technology, Engineering, and Mathematics (STEM) careers are increasingly replacing traditional jobs, offering promising opportunities for individuals with ASD who have strong skills in math, science, or computing. In this regard, Fleury et

[1] Theory of Mind (ToM) is the metacognitive ability to understand and infer that others have their own thoughts, beliefs, desires, and emotions, which may differ from one's own (Brüne & Brüne-Cohrs, 2005).
[2] Weak Central Coherence (WCC) is a cognitive theory proposing that some individuals, especially those with autism, focus on details rather than integrating information into a broader context (Happé, 2021).

al. (2014) report that although overall college enrollment is low for this population compared to other disabilities, they show the highest participation in STEM majors among students with disabilities. Despite this, challenges linked to language comprehension and executive functioning—such as slower growth in calculation skills, difficulty recalling mathematical operations, and struggle with solving word problems—can affect performance. Mathematical achievement among individuals with ASD ranges from modest weaknesses to giftedness, highlighting, yet again, the heterogeneity of cognitive profiles and the need for tailored support.

With the increasing number of students diagnosed with ASD who are expected to achieve the same academic standards as their peers, there is a rising need for interventions aimed at improving their academic outcomes. Fleury et al. (2014) catalogue a range of instructional strategies shown to support students with ASD in general education settings:

Priming: it involves preparing a student for upcoming academic material by providing a brief (10–15 minutes) preview of the activity. This can include using the actual instructional materials, outlining the steps of a task, or describing what the student will be asked to do. The strategy helps reduce stress and anxiety by making new or challenging tasks more predictable, addressing executive function difficulties related to organization and planning. Research has shown that introducing assignments in advance can improve accuracy and decrease disruptive behaviors in class (Koegel et al., 2003).

Peer support: peers without disabilities can be trained to use targeted strategies that encourage the participation of classmates with ASD during both teacher-led and student-initiated activities. This may involve adjusting instruction, such as rephrasing questions or dividing tasks into smaller steps, facilitating communication between students with ASD and their peers, and offering regular feedback. Peer support interventions have been shown to decrease students' dependence on adult assistance while fostering social interaction and engagement with the curriculum for students with ASD. For example, Carter et al. (2005) found that pairing a high school student with ASD with two typically developing peers in English class led to more consistent participation in class activities and increased time spent interacting socially with classmates.

Video modeling: an instructional approach in which students learn by watching videos that demonstrate a specific skill or behavior. This can take several forms, including basic video modeling, where a student observes someone else performing the skill; video self-modeling, in which the student watches themselves successfully completing the task; and point-of-view modeling, which shows the task from the learner's perspective to clarify each step. The method is particularly effective for students with ASD, who often struggle to learn through observation in natural settings, because it provides clear, consistent, and repeatable demonstrations that support visual processing and observational learning. Video modeling also reduces confusion or anxiety that may arise from verbal instructions alone, strengthens observational learning, and can be adapted to teach social, academic, or

behavioral skills. For example, Delano (2007) used video self-modeling to teach students the Self-Regulated Strategy Development (SRSD) approach for writing, resulting in increased word counts and more functional essay elements, highlighting the effectiveness of the approach in enhancing both skill acquisition and confidence.

Explicit strategy instruction: teaches students structured approaches to academic tasks, such as writing or math, by targeting both cognitive actions and metacognitive thinking. Students follow step-by-step routines that are often supported by mnemonics, which are memory aids—such as acronyms, rhymes, or visual cues—that help students remember the steps of a task more easily. This method capitalizes on visual strengths and strong rote memory to address everyday memory challenges.

Self-management: students are instructed to track their own behavior or performance and provide themselves with reinforcement at set intervals. The tasks and the steps required to complete them are clearly outlined, which reduces the teacher's need to give ongoing feedback and supports executive functioning skills related to self-management.

Graphic organizers: visual tools, such as Venn diagrams, Know, What, Learn (KWL) charts, flowcharts, or storyboards, used to help students organize and structure their knowledge or ideas. Because individuals with ASD often focus on details rather than the bigger picture, these tools support comprehension by helping them connect information meaningfully across a text, addressing central coherence difficulties. For example, Carnahan and Williamson (2013) found that students using keywords and Venn diagrams improved their understanding of expository science texts.

According to Sajid et al. (2024), teachers of students on the autistic spectrum can support academic success by combining formal academic strategies with behavioral interventions, often enhanced through technology. Students with ASD tend to be strong visual learners and generally respond well to computers and tablets, which can present course material in engaging, predictable ways. Technology can be integrated through individualized shared reading programs, structured training, and well-organized learning spaces. Research indicates that computer applications can also promote social and behavioral skills, while providing visual reinforcement and reducing stress by minimizing demands on interpersonal communication. Additionally, technology offers students a sense of control and predictability over their learning, increasing confidence and engagement while complementing traditional teaching methods (Jacklin & Farr, 2005, as cited in Sajid et al., 2024).

Students on the autistic spectrum can benefit from adapted shared reading activities to support literacy development. In this approach, an adult reads aloud while engaging the student with questions and discussion, tailoring the content to the child's interests and abilities. Shortened texts that maintain core concepts, themes, and plot can make literature age-appropriate while accessible. Research has shown that using visual aids, modified texts, and structured reading exercises increases both student engagement and reading comprehension, even for children with limited verbal communication skills (Muchetti,

2013, as cited in Sajid et al., 2024). These findings highlight that early, individualized literacy interventions can improve reading understanding and foster participation for students with ASD.

ASD is characterized by social communication difficulties, restricted behaviors, and sensory sensitivities, with diverse cognitive and learning profiles. Students with ASD often face challenges in social interaction, executive functioning, literacy, and written expression; however, evidence-based strategies—including priming, peer support, video modeling, explicit strategy instruction, self-management, graphic organizers, technology use, and adapted shared reading—can enhance engagement, comprehension, and independence. Emerging AI tools have the potential to further support these interventions.

2.1.2. Attention-Deficit/Hyperactivity Disorder (ADHD)

Attention-Deficit/Hyperactivity Disorder (ADHD) is a neurodevelopmental condition marked by significant difficulties with attention, organization, and/or hyperactivity-impulsivity. It can manifest as trouble sustaining focus, seeming inattentive, or often losing items required for tasks, in ways that surpass what is typical for one's age or developmental level. Hyperactivity and impulsivity may be expressed through constant movement, restlessness, difficulty staying seated, interrupting others, or impatience, also exceeding age-appropriate expectations. During childhood, ADHD commonly co-occurs with other externalizing disorders, such as oppositional defiant disorder or conduct disorder. The condition often continues into adulthood, where it can interfere with social relationships, academic achievement, and work performance (American Psychiatric Association, 2022).

Globally, ADHD affects about 8% of children and adolescents, with boys being diagnosed approximately twice as often as girls, with rates of 10% and 5% respectively, reflecting a notable gender disparity. The rates appear to be lower in adults compared to other age groups. Among the three recognized presentations of ADHD, the inattentive type (ADHD-I) emerges as the most prevalent, characterized by difficulties sustaining attention, forgetfulness, and disorganization. This is followed by the hyperactive-impulsive type (ADHD-HI), which involves restlessness, excessive activity, and impulsive behaviors, and the combined type (ADHD-C), where features of both inattention and hyperactivity-impulsivity are present. These differences in prevalence and symptom presentation highlight not only the heterogeneity of ADHD but also the importance of considering gender- and subtype-specific patterns in both research and clinical practice (Ayano et al., 2023).

Managing this lifelong condition generally involves two main approaches: non-pharmacological interventions (psychosocial treatments) and pharmacological treatment (American Academy of Pediatrics, 2001). In their account of these treatments, Wilens & Spencer (2010) synthesize several studies on ADHD medication. The results indicate that pharmacological management plays the most significant role in reducing core ADHD

symptoms during the initial one to two years of multimodal treatment. The main drug classes include stimulants, noradrenergic agents, and alpha agonists, all of which demonstrate effectiveness across the lifespan. Stimulants are the first-line choice due to their strong evidence of efficacy and safety, with methylphenidate formulations and amphetamine formulations being the most widely used. Methylphenidate works by blocking dopamine and norepinephrine transporters, while amphetamines not only block these transporters but also release stored catecholamines, thereby boosting synaptic dopamine and norepinephrine levels. As for the non-pharmacological interventions, recommended approaches can be grouped into three categories: behavior management interventions, which include parent training, classroom strategies, and peer-based programs; training and cognitive interventions, such as cognitive training, neurofeedback, organizational skills training, and cognitive-behavioral therapy (CBT); and physiological treatments, including structured physical activity programs (for review see Shrestha et al., 2020).

Equipping parents with the tools to deal with their child's condition is crucial for effective intervention. Behavioral Parent Training (BPT) is one of the widely known effective therapies in treating ADHD; it typically follows the Antecedent–Behavior–Consequence (ABC) approach. This training can be delivered through multiple formats, including small or large group sessions, individualized family consultations, instructional videotapes, and interactive behavioral sessions that involve both parents and children. These diverse approaches allow parents to learn strategies for reinforcing positive behaviors, managing challenges effectively, and applying consistent behavioral techniques in real-life settings, thereby enhancing the child's overall functioning (Van Den Hoofdakker et al., 2007).

Teachers can complement the effort done at home by implementing both individual and classroom-wide strategies using the ABC approach (Barkley, 2005). Antecedent interventions focus on identifying and addressing triggers of problematic behavior, such as boredom, peer provocation, or inconsistent rules. Interventions that combine antecedent and consequence strategies involve recognizing the causes of inappropriate behavior while reinforcing positive behaviors through rewards. Consequence-based interventions, on the other hand, use carefully applied disciplinary measures to promote appropriate behavior in the classroom (Wilens et al., 2010). A concrete application of the ABC model is found in the Behavioral Classroom Management (BCM), which is a structured evidence-based approach designed to improve the behavior and academic performance of children with ADHD and other behavioral challenges within the school setting. The BCM involves setting clear behavioral expectations, consistently monitoring student behavior, and providing immediate reinforcement for positive actions while applying predictable consequences for inappropriate behaviors. Key strategies include structured routines, token economies, contingent praise, and instructional modifications to support learning (Pelham Jr. & Gregory, 2008).

Peer-based interventions have demonstrated positive results in improving the social relationships of children with ADHD, who frequently experience significant difficulties in peer interactions, with more than half experiencing challenges in forming friendships. However, further research is needed to strengthen the evidence base supporting their effectiveness in ADHD management. These interventions are typically group-based and include three main approaches: peer involvement, where peers support each other through strategies like sharing, helping, or praising; peer-mediated interventions, in which trained peers provide instruction and guidance to the target child; and peer-proximity interventions, where skilled peers are placed in close proximity to model appropriate behaviors (Shrestha et al., 2020).

Beyond traditional psychosocial interventions that are known to benefit individuals with ADHD, tutors play an important role in supporting students by fostering academic skills, social development, and personal growth. They not only teach strategies for organization and prioritization but also serve as mentors and motivational figures, bridging the gap between emotional support and practical skill-building (Wilens et al., 2010). Most children with ADHD require individualized educational planning (IEP) tailored to their specific challenges, particularly since learning disorders frequently co-occur. Comprehensive support should include early screening, development of individualized education plans, and collaboration between parents, teachers, school counselors, and psychologists. Educational adjustments—such as structured routines, learning aids, additional resource support, and regular monitoring of homework—are vital for improving both academic and behavioral outcomes. Consistent communication between parents and schools further strengthens progress, and similar structured strategies at home can enhance the child's ability to manage tasks effectively (Wilens & Spencer, 2010).

2.1.3. Dyslexia

Dyslexia does not have a single agreed-upon definition, as scholars interpret it differently. Ried (2009) highlights that defining dyslexia is particularly challenging because of its complexity, and no definition can be regarded as universally accepted. He explains that people with dyslexia experience the condition in varied ways, which shapes their personal interpretations and perspectives. This implies that although certain contributing factors are commonly recognized, the manifestation of dyslexia can vary considerably from one individual to another. Despite the lack of universal agreement on its definition, the International Dyslexia Association (IDA) has, since 2002, defined dyslexia as "a specific learning disability that is neurobiological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in

reading comprehension and reduced reading experience that can impede the growth of vocabulary and background knowledge" (IDA, 2002). Its prevalence estimates vary widely—from under 5% to 20%—due to continuous variation in reading ability, differing diagnostic definitions, and the unreliability of identification methods (Wagner et al., 2020).

Snowling et al. (2020) criticize the discrepancy-based model of diagnosing dyslexia, arguing that it fails to distinguish clearly between children with dyslexia and those with broader learning difficulties, as both groups show similar reading and phonological deficits. They note that expanding the definition has created confusion around the diagnosis and even suggest that a new term may be necessary. The authors also emphasize the importance of recognizing comorbidities, with Moll et al. (2020) reporting that about 40% of children with dyslexia or reading disorders also have another neurodevelopmental condition. To reduce confusion surrounding the term *dyslexia*, the DSM-5 adopts the label *Specific Learning Disorder with impairment in reading*, classifying it as a type of neurodevelopmental disorder. Such disorders are typically heritable, often genetic, and lifelong in nature, with symptoms appearing early in development—dyslexia usually emerging in the preschool years. According to the DSM-5, this condition is defined as a persistent pattern of reading difficulties, including inaccurate or slow word recognition, poor decoding, and weak spelling, that continues for at least six months despite targeted intervention. Furthermore, a key indicator is notably low academic achievement relative to age, or performance maintained only through unusually high effort or external support.

Dyslexia is widely linked to deficits in phonological processing, which encompasses several interconnected skills. Phonemic awareness, the ability to identify and manipulate individual sounds, underpins early reading development. Extending this, phonological awareness includes broader abilities such as rhyming, blending, and segmenting, and tends to develop from larger sound units to smaller ones, with recognition typically preceding manipulation. This progression is not strictly linear but rather overlapping and fluid. In addition, phonological memory supports the temporary storage of sound sequences, while phonological processing speed enables rapid retrieval of phonological information. Collectively, weaknesses across these areas explain many of the reading difficulties associated with dyslexia (Anthony & Francis, 2005). Research indicates that individuals with dyslexia often demonstrate weak phonological awareness (Catts et al., 2005), along with limitations in verbal short-term memory (Szenkovits & Ramus, 2005) and slowed phonological processing speed (Wolf & Bowers, 1999). In addition, some studies report deficits in auditory discrimination despite otherwise normal auditory acuity (Orton, 1937; Bannatyne, 1974, as cited in Snowling et al., 2020).

In its resource kit for teachers, the IDA (2017) underscores a range of signs and symptoms that can indicate dyslexia, stressing the importance of early evaluation to ensure appropriate support. In general, individuals with dyslexia may struggle with speaking,

learning letters and sounds, organizing language, memorizing number facts, reading fluently, comprehending longer texts, spelling, learning foreign languages, and performing math operations accurately. For elementary-aged children, more specific difficulties can include trouble remembering simple sequences (such as counting, days of the week, or the alphabet), recognizing rhymes or words with the same initial sound, pronunciation issues, clapping to rhythms, word retrieval challenges, and remembering names, places, or spoken instructions. However, the IDA cautions that experiencing these difficulties does not automatically mean a child has dyslexia, as formal testing is required for diagnosis.

Research has long emphasized the importance of early identification and intervention for dyslexia (Snowling, 2013), with studies showing that language and literacy precursors, such as letter-sound knowledge and phonemic awareness, can predict later outcomes at a group level (Muter et al., 2004), though predictions at the individual level remain challenging (Puolakanaho et al., 2007). Alternative approaches such as Response to Intervention (RTI) allow teachers to monitor children's progress and identify those who fail to respond to high-quality teaching (Fletcher et al., 2007), potentially enabling timely support without waiting for diagnostic thresholds. Evidence from the Early Years Foundation Stage Profile (EYFSP) in the UK shows that teacher assessments at year 2 are strong predictors of literacy achievement at the end of year 3, with communication, language, and literacy scores explaining about half the variance in later reading and writing outcomes. Follow-up studies further confirm that children identified as "at risk" through phonics monitoring display core dyslexic features, including deficits in phonological awareness, verbal memory, and processing speed. Collectively, these findings highlight that schools already collect sufficient data to identify children at risk of dyslexia and that embedding systematic teacher-led assessments and RTI frameworks provides an effective, cost-efficient approach to early detection and intervention (Snowling, 2013).

Snowling & Hulme (2011) highlighted the core components of evidence-based interventions for language and literacy challenges. They emphasize that effective programs should be structured, systematic, and multi-sensory, incorporating explicit instruction, opportunities for practice, and frequent review to accommodate children's limited attention and learning difficulties. For students with dyslexia, interventions should focus on teaching letter-sound relationships, phonemic awareness, and connecting letters and sounds through both writing and level-appropriate reading tasks to strengthen emerging skills. Conversely, children with comprehension difficulties require approaches tailored to oral language development, particularly vocabulary enrichment (Clarke et al., 2010). Since many learners experience difficulties with both decoding and comprehension, a blended approach is often necessary.

2.2. Etiological Factors of Neurodevelopmental Disorders

Although the precise causes of learning disabilities are unclear, research has identified several contributing risk factors and a high likelihood of a genetic basis. Notably,

children with a family history of learning disability face a higher probability of developing one themselves. However, the absence of a hereditary history does not negate the genetic etiology of these neurodivergencies, as stated by Foster et al. (2015), who elaborate that evidence indicates that a wide range of environmental factors may contribute to the development of learning disabilities before, during, or after birth. These include prenatal infections; maternal health conditions; exposure to harmful substances like sodium valproate, prescription and recreational drugs; birth complications such as asphyxia; and issues related to prematurity. Maternal alcohol consumption during pregnancy has been shown to adversely affect cognitive development, including attention, memory, and mathematical skills (Mattson et al., 2011). Exposure to environmental toxins such as lead, even at low levels, is associated with impaired intellectual functioning and behavioral problems in children (Feldman & White, 1992; WHO, 2024). Nutritional deficiencies during infancy, particularly iron deficiency—which infants are highly vulnerable to—have been associated with lasting effects on cognitive, motor, and socio-emotional development. Longitudinal studies and animal research indicate that these outcomes result from disruptions in brain development, including altered neurometabolism, myelination, and neurotransmitter function, highlighting the critical importance of adequate early iron nutrition (Lazoff et al., 2006).

Similarly, the development of ASD is influenced by multiple factors, arising from intricate interactions between genetic susceptibility and environmental conditions. ASD is believed to be primarily influenced by genetic factors. This theory is substantiated with the results of twin studies that have shown high concordance rates for ASD in monozygotic twins, indicating a strong hereditary component. For reference, the concordance rate for ASD in monozygotic twins is reported to be between 70% and 90%, compared to up to 30% in dizygotic twins (Rosenberg et al. 2009; Hallmayer et al. 2011; Ronald & Hoekstra, 2014 as cited in Wiśniowiecka-Kowalnik & Nowakowska, 2019). Additionally, environmental factors also contribute to the risk of developing ASD. Prenatal exposures, such as maternal infections, advanced parental age, and complications during pregnancy, have been associated with an increased risk of ASD. Additionally, perinatal factors like low birth weight and prematurity may further elevate this risk (Hodges et al., 2020).

Akin to ASD, ADHD has a strong genetic basis. Family, twin, and adoption studies indicate that ADHD is highly heritable, with estimates of heritability ranging from 70% to 80% (Faraone & Larsson, 2019). Furthermore, studies indicate that ADHD is a polygenic condition, with multiple genes influencing brain development and function. Two frequently studied candidates are the brain-derived neurotrophic factor[3] (BDNF) and the dopamine transporter gene (DAT) (Núñez-Jaramillo et al., 2021). Environmental factors are also contributive in developing ADHD. Prenatal and perinatal influences, including

[3] A protein that supports neuronal survival and growth, modulates neurotransmitter activity, and facilitates neuronal plasticity, which is crucial for learning and memory (Bathina & Das, 2015).

premature birth, maternal malnutrition, immune activation, and prenatal exposure to toxins or high sugar intake, can disrupt neurogenesis and dopaminergic pathways. Early-life exposure to heavy metals and pesticides has also been linked to ADHD symptoms, while sleep disturbances can exacerbate or mimic core behavioral traits (Núñez-Jaramillo et al., 2021). Together, these findings highlight that ADHD results from complex interactions between inherited genetic vulnerabilities and environmental exposures, emphasizing the need for holistic approaches in both research and clinical practice.

In sum, learning disabilities, ASD, and ADHD arise from complex interactions between genetic predispositions and environmental factors. While heredity plays a central role, prenatal health, nutrition, and exposure to toxins also significantly shape outcomes. Raising awareness among parents, educators, and healthcare providers is essential for early recognition, while preventive measures—such as safeguarding maternal health, reducing environmental risks, and ensuring proper nutrition—can mitigate vulnerabilities.

3. Research on AI Tools for Neurodiverse Learners

Recent advances in artificial intelligence (AI) have opened new possibilities for supporting neurodiverse students in educational settings. Research increasingly explores how AI tools can assist learners with conditions such as ADHD, ASD, and dyslexia by providing personalized learning experiences, scaffolding attention and executive functions, and enhancing reading and comprehension skills. This section reviews studies that examine the effectiveness and implications of AI-assisted learning for these populations, highlighting how technology can complement traditional interventions and foster more inclusive classrooms.

3.1. AI Applications for Learners with Autism Spectrum Disorder

AI is increasingly used in autism diagnosis and support, with smartphone apps and tools aiding detection and helping improve social, communication, and emotional skills. While not a substitute for personalized treatment, AI models like ChatGPT provide accessible information and guidance for parents, therapists, and individuals. Beyond support for people with ASD, AI fosters acceptance and empathy by helping typically developing individuals better understand neurodiverse perspectives. Overall, AI offers practical benefits such as sensory management, structured routines, adaptive communication, and individualized support (Moraiti & Drigas, 2023).

Dechsling et al. (2022) conducted a scoping review of 49 studies exploring the use of virtual reality (VR) and augmented reality (AR) technologies in social skills interventions for individuals with autism spectrum disorder (ASD). Their review highlights that VR- and AR-based tools are promising, widely accepted by individuals with ASD, and particularly focused on children and adolescents, though very young children and adults remain underrepresented. The studies reviewed were generally small-scale, with limited

female participation, reflecting a gap in inclusivity. While many interventions demonstrated potential for improving social skills, the paper emphasizes the need for more rigorous research designs that integrate VR/AR with evidence-based intervention strategies to establish stronger empirical support. Their general conclusion was that VR and AR hold considerable promise for enhancing social skills interventions in ASD, but future research must address methodological limitations, participant diversity, and scalability.

Traditional assessment methods (e.g., standardized tests, teacher-led evaluations, written examinations, and IQ-based measures such as the Wechsler Intelligence Scale for Children) often fail to account for the unique learning styles and cognitive and sensory profiles of learners with ASD. This limitation reduces their effectiveness in evaluating progress within AI-assisted education. To address this, researchers propose novel AI-specific metrics that combine quantitative indicators (e.g., task accuracy, completion rates, and response times adjusted for cognitive and motor differences) with qualitative measures (e.g., engagement, emotional responsiveness, and independent exploration). These metrics complement conventional assessments by leveraging real-time data and adaptive learning to provide more accurate, inclusive, and personalized evaluations (Adako et al., 2025). Practical examples include CogniAble, which uses facial recognition and behavior tracking for real-time screening, and AlterEgo, a wearable device that translates internal speech into text for non-verbal children. Other tools, such as Empowered Brain and Affectiva, employ augmented reality and emotion-recognition technologies to monitor social engagement and provide immediate feedback. Similarly, adaptive platforms like Jasper personalize social skills interventions by analyzing eye contact, speech, and reaction times. Collectively, these AI-driven systems illustrate how technology can enrich assessment practices beyond traditional methods by capturing both cognitive and socio-emotional dimensions of learning (Adako et al., 2025).

3.2. AI Tools for Students with ADHD

In their systematic review, Hardiani et al. (2025) state that preliminary studies on some AI-powered applications have demonstrated promise in supporting children with ADHD in their education. For example, EndeavorRx—an FDA-approved digital therapeutic game—employs AI to adapt gameplay based on a child's performance, specifically targeting attentional control. Similarly, programs like Cogmed Working Memory Training and NeuroPlus use AI to monitor and respond to user interactions, providing immediate feedback to maintain engagement. These tools leverage data-driven personalization to improve focus, a critical skill for learners with ADHD. The article concludes that despite encouraging early results of the reviewed studies, longitudinal research is still necessary to confirm sustained benefits of these tools.

Sun et al. (2025) carried out a scoping review of 52 studies to map how AI is being used for children with ADHD. They noted that most of the research focused on AI for

diagnosis, often using brain imaging data (MRI). The review found that machine learning methods (ML)—especially support vector machines (SVMs)—were the most common, though deep learning (DL) approaches like Convolutional Neural Network[4] (CNNs) achieved the highest accuracy, with some models reaching over 98%. However, many studies relied on small datasets, and validation methods were fairly limited. They concluded that AI shows strong potential to improve diagnostic accuracy and support clinical decisions, but stress the need for larger, more rigorous studies before these tools can be widely adopted.

Somma et al. (2021) reviewed several studies conducted to evaluate AI-powered applications designed to support children with ADHD, highlighting their adaptive, gamified, and data-driven features. TALI Train™ adjusts task difficulty based on each child's abilities and provides visual, verbal, and motivational support, with progress tracked through achievement, accuracy, and reaction time. Studies reported modest improvements in selective attention and numeracy skills, though effects on sustained attention and behavioral attention were limited. Braingame Brian personalizes task difficulty in real time and uses gamified worlds to engage children, showing reductions in ADHD behaviors and gains in inhibition, but not consistently in working memory or set-shifting. Play Attention integrates neurofeedback to modulate theta/beta brainwave ratios, improving attention and executive function while reducing reliance on stimulant medication. ATENTIVmynd™ Games uses electroencephalography[5] (EEG)-based feedforward modeling to monitor attention and provide real-time feedback in gamified tasks, demonstrating improvements in attention and functional brain connectivity. Cogmed Working Memory Training® focuses on working memory exercises with adaptive difficulty and online monitoring; studies showed gains in nonverbal and verbal storage but limited impact on ADHD symptoms or academic achievement.

Aldakhil (2024) demonstrated that AI-based play activities significantly improve the quality of life for children with ADHD. In a study of 61 children aged 8–12, participants who engaged in twelve 45-minute AI-guided play sessions showed gains across all Pediatric Quality of Life Inventory (PedsQL) dimensions, which were sustained at a 7-week follow-up. The findings suggest that AI-driven interventions can enhance behavioral, social, and cognitive outcomes and highlight the potential of integrating such approaches into educational and therapeutic settings for children with ADHD. Additionally, Shpakivska Bilan et al. (2024) reported that an adaptive, game-based cognitive therapy, targeting 14 cognitive tasks based on neuropsychological paradigms (e.g., go/no-go, n-

[4] A type of deep learning model that automatically learns spatial hierarchies of features from input data, commonly used for tasks like image and pattern recognition. CNNs use layers of convolutions, pooling, and fully connected nodes to extract and classify features efficiently (Taye, 2023).

[5] A non-invasive technique for recording the brain's electrical activity. It involves placing small electrodes on the scalp to detect the electrical signals generated by neurons, which are then recorded as wave patterns reflecting neural activity (Rayi & Murr, 2022).

back) that were continuously adapted by AI according to each child's performance, not only reduced impulsiveness and inattention but also produced neurophysiological improvements, with progress in inhibitory control linked to normalized MEG spectral profiles and significant improvements in attention and impulsivity, alongside enhanced inhibitory control, cognitive flexibility, and spatial working memory in their experimental group.

3.3. AI Support for Students with Dyslexia: From Detection to Intervention

The integration of artificial intelligence (AI) has dramatically enhanced early dyslexia detection by introducing non-invasive, highly accurate diagnostic tools that outperform traditional methods. AI-driven models employing machine learning (ML) and deep learning (DL) algorithms have been used to analyze diverse behavioral data—such as eye movement patterns, handwriting characteristics, and speech signals—to identify markers of dyslexia in children (Yap et al., 2025). For example, researchers combining eye-tracking data with machine learning classifiers have achieved very high classification accuracies ranging between 88.58% using a random forest classifier (Cogan et al., 2025), 94% using multiple algorithms (e.g., logistic regression, support vector machine, k-nearest neighbor, and random forest) while taking into consideration the effect of color on the inter-subject variability (Vajs et al., 2022).

The influence of color on reading time has been supported by a study that measured electroencephalography (EEG) activity, heart rate variability (HRV), electrodermal activity (EDA), and eye movements in children with dyslexia and controls. The results revealed that children with dyslexia consistently demonstrated longer reading durations, with fewer and longer fixations and saccades, indicating that their reading was slower and less efficient than that of their non-dyslexic peers, regardless of colour condition. However, certain colours, specifically turquoise backgrounds and overlays and yellow backgrounds, significantly improved the reading performance of children with dyslexia, resulting in shorter reading times (Jakovljević et al., 2021).

Rangasrinivasan et al. (2025) address the need for early, efficient, and accessible screening tools for two common learning disabilities: dyslexia and dysgraphia. They argue that current screeners are limited because they are costly, time-intensive, and typically focus on either dyslexia or dysgraphia in isolation, often neglecting writing-based behaviors. Most dyslexia tools rely on oral and speech tasks, leaving out handwriting analysis, which can reveal important behavioral indicators for both conditions. The authors propose an AI-integrated screening framework that enhances handwriting evaluation by detecting dyslexia and dysgraphia indicators in children's writing. Grounded in the Dysgraphia and Dyslexia Behavioral Indicator Checklist (DDBIC), the framework integrates expert-defined criteria from speech-language pathology and occupational therapy—17 indicators, including four observed during writing (e.g., grip, pressure, speed, engagement) and 13 analyzed afterward, spanning dysgraphia-specific, shared, and

dyslexia-specific markers—with machine learning trained on handwriting datasets. Using five analytical modules (Temporal, Structural, Handwriting Recognition, Semantic, and Post-processing/Fusion), the framework ensures a practitioner-aligned system for large-scale, explainable screening.

Aldehim et al. (2024) present another DL based approach for dyslexia detection using handwriting analysis. Their study employs a CNN model tailored for image-based handwriting analysis, focusing on accurately identifying the subtle features that differentiate dyslexic handwriting from typical writing. The model's performance is benchmarked against existing detection methods, showing superior accuracy and efficiency. These findings highlight the potential of CNN-driven handwriting analysis as a reliable tool for early dyslexia screening and intervention. Another use of CNN is Yogarajah and Bhushan (2021), who developed a DL based system for automated detection of dyslexia and dysgraphia using handwriting samples from 54 children aged 6–10. The system analyzed 267 images of selected Hindi words with a CNN, achieving an average accuracy of 86.14%. The study demonstrates that deep learning can effectively identify handwriting features indicative of dyslexia and dysgraphia, supporting automated screening and early detection.

Recent research underscores the transformative role of AI not only in screening and diagnosis but also in personalized learning for students with dyslexia, as intelligent systems adapt educational content and methods to individual cognitive profiles and evolving needs (Yap et al., 2025). Examples include Intelligent Tutoring Systems (ITS) tailored for learning disabilities (Ahuja et al., 2022); multimodal interactive applications for letter and color recognition (Al Omoush et al., 2023); and a Fuzzy Min-Max Neural Network[6] (FMMNN) based ITS that identifies learner characteristics to deliver customized experiences (Dutt et al., 2022). Further developments, such as language learning models with real-time feedback, demonstrate how AI-driven tools can provide responsive, engaging, and inclusive learning environments. Collectively, these innovations highlight AI's potential to improve engagement, accessibility, and learning outcomes for students with dyslexia by aligning instruction with each learner's trajectory (Yap et al., 2025).

Systematic reviews indicate that tools such as speech-to-text (STT), text-to-speech (TTS), and audiobooks positively impact reading and writing skills in students with learning disabilities, including dyslexia (Perelmutter et al., 2017). Studies also suggest that STT and TTS can foster greater independence, engagement in school activities, motivation, and learning satisfaction, especially when tailored to individual needs (Nordström et al., 2018; Svensson et al., 2021). However, research comparing text comprehension between audiobooks and printed text remains limited, which calls for further investigation into learner

[6] A neural network that combines fuzzy logic and neural learning by using hyperboxes to handle uncertainty, enabling adaptive, real-time pattern recognition while improving generalization and reducing overfitting (Nature, n.d.).

characteristics—such as motivation, perception, and attitudes—to better understand how these factors influence comprehension across different media (Singh & Alexander, 2022).

Anderle et al. (2025) conducted a pilot study exploring two gamified digital tools for supporting decoding and writing skills in students with diverse learning profiles, including those with special educational needs (SEN). Both neurotypical and SEN participants showed gains in decoding fluency, accuracy, and writing, alongside high engagement and acceptability. However, some improvements among SEN groups did not reach statistical significance, underscoring the need for personalized approaches and highlighting the potential of gamified tools as inclusive complements to traditional instruction.

Bäcka et al. (2023) conducted a five-year follow-up study to explore the long-term experiences of Swedish students with dyslexia using assistive technology (AT). They interviewed nine students using a semi-structured framework and analyzed the responses thematically. Three main themes emerged: contextual factors, emotional responses, and the development of meaningful strategies. The researchers found that audiobooks remained consistently helpful throughout the school years, text-to-speech (TTS) was mainly used for decoding, and speech-to-text (STT) showed mixed effectiveness. Sustained AT use was influenced more by school organization, students' acceptance of their dyslexia, and their attitudes toward AT, rather than by accessibility alone. Bäcka et al. (2023) concluded that effective AT support requires systematic training, attention to emotional responses in the classroom, and ongoing guidance to help students develop strategies for both basic and higher-level learning skills.

Kostadinovska-Stojchevska & Shalevska (2024) argue that AI tools like ChatGPT provide context-aware writing support that goes beyond basic spellchecking, offering real-time feedback on grammar, style, and vocabulary. By suggesting synonyms, improving arguments, and guiding text organization based on user input, ChatGPT helps students with dyslexia overcome challenges that extend beyond spelling, particularly in foreign language learning, where limited vocabulary and grammar knowledge can hinder writing development. They add that ChatGPT can address the challenges that students with dyslexia face with vocabulary retention by creating personalized, adaptive exercises aligned with each student's learning curve, curriculum, and preferences. These tools transform vocabulary practice into an interactive and engaging experience, fostering deeper language comprehension rather than simple rote memorization. Examples include interactive flashcards with audio pronunciations, contextual sentence generation, and gamified activities like crossword puzzles and word searches. However, while AI can offer valuable support, some researchers stress that these tools should be carefully integrated, educational institutions need to revise and modernize training for students and teachers, as well as policies and assessment methods in writing courses to address issues related to academic integrity, including plagiarism, AI-generated work, online or home-based exams, and challenges posed by automated error-correction (Imran & Almusharraf, 2023).

4. Challenges and Ethical Considerations in AI-Powered Support

The use of AI-based systems in education, while promising, also presents important limitations that must be acknowledged. First, equitable access remains a challenge, as not all families or schools possess adequate digital devices or reliable internet connections, potentially widening the digital divide and excluding disadvantaged learners from benefiting fully from these technologies. Second, prolonged and unsupervised use of AI applications may create risks of overreliance on technology, leading to reduced self-regulation skills, diminished face-to-face interactions, and excessive screen exposure, which can negatively impact physical and mental health. Third, privacy and data security concerns represent a critical barrier, particularly since many AI-based systems rely on collecting and analyzing sensitive personal and behavioral information. Without robust safeguards, there is a heightened risk of misuse, unauthorized access, or breaches of children's data, which can undermine trust and ethical implementation in educational settings (Hardiani et al., 2025). These limitations highlight the need for careful design, responsible use, and strong policy frameworks to ensure that AI tools support learning without introducing unintended harms.

In their review, Adako et al. (2025) emphasize that AI holds considerable promise for enhancing education for children with autism spectrum disorder (ASD), but its implementation faces multiple challenges. Ethical concerns, including consent, data privacy, and responsible use, are central, while algorithmic bias—often resulting from homogeneous training data—can misinterpret autistic behaviors or reinforce stereotypes. Accessibility barriers and the diverse learning needs of students with ASD further complicate effective implementation, highlighting the need for adaptive, inclusive, and transparent AI tools to ensure equitable and effective educational outcomes.

Similar limitations are evident in ADHD assessment and management. AI tools in this context face issues of bias and discrimination, particularly when training datasets are unrepresentative, which can reduce model accuracy for marginalized populations. Privacy concerns are also prominent, as these systems often collect sensitive personal information—including location, medical history, and behavioral data—that may be misused without proper consent. Additionally, the lack of transparency and interpretability in AI predictions can hinder clinicians' understanding of model outcomes. Incorporating clinician input and providing explanations through knowledge-based visualizations may improve both transparency and trust in AI-assisted ADHD detection (Rahman, 2023).

Extending these observations to dyslexia, a recent scoping review by Yap et al. (2025) identifies parallel challenges in AI-based dyslexia detection and support. Key issues include limited, imbalanced, or inconsistent datasets that reduce model accuracy and generalizability, particularly across diverse linguistic contexts. Accessibility challenges—such as inadequate infrastructure, high costs, and the digital divide—disproportionately affect learners in low-resource settings. Bias and validity concerns further complicate AI

implementation, as homogeneous training data and poor image or text quality can lead to inaccurate or discriminatory outcomes. Moreover, balancing AI support with professional expertise is critical, since over-reliance on AI can undermine educators' nuanced judgment. Finally, transparency in AI decision-making remains a persistent barrier; the opaque processes of many deep learning models limit users' understanding and trust, challenging ethical accountability and effective integration in educational settings.

5. Conclusion

The integration of AI into inclusive education offers significant potential to transform learning experiences for neurodivergent students. AI-powered tools—including intelligent tutoring systems, speech and language technologies, chatbots, and gamified applications—can provide personalized, adaptive, and engaging support tailored to the diverse needs of learners with ASD, ADHD, and dyslexia. These technologies have the capacity to enhance screening, assessment, and behavioral interventions, promoting more equitable and effective educational outcomes. However, the promise of AI is tempered by substantial challenges, such as ethical considerations, data privacy risks, algorithmic bias, and disparities in access to technology. Addressing these issues requires careful system design, ongoing human oversight, and policy frameworks that prioritize inclusivity and equity. Future research should focus on refining AI interventions, ensuring transparency, and evaluating long-term outcomes to maximize their benefits while minimizing potential harm. Overall, AI represents a powerful tool for supporting neurodivergent learners, but its effective implementation depends on balancing technological innovation with ethical, practical, and educational considerations.

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The Role of AI in Supporting Teaching in Mixed-Ability Classrooms

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Mixed-ability classrooms, where students exhibit diverse levels of knowledge, skills, and learning styles, present both opportunities and challenges for educators. This article explores the core principles of mixed-ability teaching, including differentiation, inclusive pedagogy, and adaptive assessment. It also addresses key challenges such as managing varying paces of learning, maintaining student engagement, and ensuring equitable participation. The article argues that artificial intelligence (AI) offers powerful, practical solutions to these challenges. AI can support teachers through personalised learning platforms, intelligent tutoring systems, real-time analytics, and content generation tools that adapt to individual student needs. Each proposed solution is illustrated with real-life classroom examples to demonstrate feasibility and impact. By integrating AI thoughtfully, educators can enhance learning outcomes, streamline instructional planning, and foster a more inclusive and supportive learning environment. This paper highlights the potential of AI not to replace teachers, but to empower them in delivering effective, differentiated instruction in diverse classrooms.

Artificial intelligence; mixed-ability classrooms; differentiated instruction; inclusive pedagogy; teacher support; educational technology.

1. Introduction

In today's increasingly diverse classrooms, the term *mixed abilities* has become both a pedagogical challenge and a call to action. Teachers are tasked with delivering instruction that is inclusive, effective, and responsive to students who differ significantly in skills, experiences, and learning profiles. Nowhere is this more apparent than in English language classrooms, where learners may follow the same curriculum but vary widely in their linguistic competence, cognitive speed, engagement styles, and personal backgrounds.

In April 2025, a group of 90 English language teachers from Romania—representing primary, secondary, high school, and university levels—responded to the question: *What can mixed abilities refer to in a class?* Their answers illustrate the practical and layered complexity of teaching in such environments. While some teachers described mixed abilities

in terms of language proficiency, noting that students may range from A1 to C2 levels, others expanded the concept to include different learning styles, cognitive capacities, emotional maturity, and motivation. One teacher remarked that a mixed-ability class may contain "students who have different levels of English (sometimes ranging from A1 to C2)," while another noted the presence of "different learning speeds… different ways of understanding and memorizing information." Several educators also emphasized cultural diversity, learning behaviour, and emotional resilience, with one response encapsulating the inclusive spirit of teaching: "Children come from different environments, with different skills, with different learning behaviour. Everyone can do SOMETHING in the class."

This practitioner – informed understanding of mixed abilities aligns with scholarly conceptions found in differentiated instruction, inclusive pedagogy, and universal design for learning. The foundational work of Tomlinson (2001) on differentiated instruction emphasizes tailoring teaching methods to students' readiness levels, interests, and learning preferences. Similarly, Florian and Black-Hawkins (2011) propose that inclusive pedagogy requires educators to view learner difference not as a problem to be fixed but as a resource to be valued. Despite the theoretical clarity of these frameworks, many educators continue to struggle with their implementation in real-world classrooms due to constraints such as time, class size, rigid curricula, and assessment pressures.

It is within this gap between theory and practice that artificial intelligence (AI) has begun to make a meaningful intervention. AI-based tools now promise to assist teachers in managing learner diversity through adaptive learning technologies, intelligent tutoring systems, automatic assessment and feedback, and AI-generated multilingual content. These systems have the potential to personalize learning pathways, monitor progress in real time, and reduce administrative burdens on teachers. Scholars such as Zawacki-Richter et al. (2019) and Hooda et al. (2022) argue that AI's role in education is not to replace educators but to empower them by expanding their instructional toolkit.

This article explores the role of AI in supporting teaching in mixed-ability classrooms by analyzing both the challenges these environments pose and the technological solutions that AI may offer. By integrating international research with empirical data collected from Romanian teachers, the article aims to assess how AI can be used to promote educational equity, enhance engagement, and support personalized learning without compromising the teacher's professional autonomy or ethical responsibility. In doing so, it contributes to a growing body of literature on AI in education, positioning teachers not as passive adopters but as critical agents shaping how technology is integrated into inclusive pedagogy.

2. Conceptual and Theoretical Framework

The concept of *mixed-ability classrooms* has been a subject of pedagogical discourse for decades, reflecting the reality that students within a single learning

environment often exhibit wide variations in ability, prior knowledge, motivation, and learning styles. Differentiated instruction, as articulated by Tomlinson (2001), emphasizes that effective teaching in such contexts requires an intentional adaptation of content, process, and assessment to align with learner readiness, interest, and learning preferences. Similarly, inclusive pedagogy, as advanced by Florian and Black-Hawkins (2011), positions diversity as a resource rather than a limitation, calling upon teachers to design instruction that engages all learners rather than targeting a perceived "average" student. These frameworks underpin the theoretical foundation for addressing learner diversity, and they remain central to understanding the challenges that artificial intelligence seeks to mediate.

In educational settings, artificial intelligence refers to the use of computational technologies that replicate elements of human cognition, including adaptive learning processes, language understanding, and data-driven predictions, to support teaching and learning. While its early development focused on intelligent tutoring systems and algorithmic assessments, the recent evolution of AI tools has broadened the possibilities for supporting personalized learning, inclusive practices, and real-time feedback (Zawacki-Richter et al., 2019). In particular, adaptive learning technologies promise to reduce the burden of differentiation by automatically adjusting instructional material to learners' needs (Dagunduro, Chikwe, Ajuwon, & Ediae, 2024), while AI-driven assessment and feedback tools have demonstrated potential for increasing student engagement and academic success (Hooda, Rana, & Dahiya, 2022).

However, the role of AI must be framed carefully within a broader pedagogical discourse. It is not AI itself that threatens to replace teachers, but rather the possibility that educators who resist engaging with AI tools may find their practices increasingly misaligned with the expectations and realities of contemporary classrooms. As such, AI should not be understood as a substitute for teachers, but rather as a catalyst for pedagogical transformation. In this context, it is not AI itself that displaces educators, but rather the reluctance to adopt and adapt to AI that may render certain teaching practices obsolete. This perspective underscores the importance of professional development, critical reflection, and ethical adoption, ensuring that AI complements rather than undermines the professional expertise of teachers.

Finally, taken into consideration all the above mentioned, it is necessary to admit the need for a balanced perspective. The introduction of AI into mixed-ability classrooms is not a neutral act but one situated within debates about equity, access, and ethics. Scholars have raised concerns regarding bias in AI algorithms, data privacy, and the risk of reinforcing inequalities if access to AI resources is uneven (OECD, 2024; Lim, Gottipati, & Cheong, 2023). Thus, any analysis of AI's role in education must move beyond technical capabilities to consider its alignment with broader goals of inclusion, fairness, and empowerment.

3. Literature Review

The idea of mixed-ability classrooms has often been explored in educational studies, as it reflects the everyday reality of teachers who face the challenge of supporting students with very different needs in one learning environment. Tomlinson's (2001) work on differentiated instruction remains foundational, emphasizing the adaptation of content, processes, and learning outcomes according to student readiness, interests, and profiles. This theoretical position has been reinforced by research into inclusive pedagogy, which emphasizes that learner diversity should not be treated as a barrier but as a valuable asset to classroom learning (Florian & Black-Hawkins, 2011). More recent studies point to the lived experiences of teachers who encounter this diversity on a daily basis. Patel and Kim (2024) showed that teachers in special education describe differentiation as a constant balancing act between meeting curricular expectations and addressing individual student needs, a process that is both rewarding and demanding. These findings resonate with the responses collected from Romanian English teachers in the present study, who defined mixed abilities not only in terms of knowledge and language proficiency but also in relation to motivation, learning pace, and socio-emotional development.

Although differentiation has traditionally relied on what teachers themselves could design and implement, the reality of increasingly diverse classrooms has led many to consider technology as a way of easing this burden and extending support. Luckin, Holmes, Griffiths, and Forcier (2016), in their influential report *Intelligence Unleashed: An Argument for AI in Education*, highlighted the promise of AI in enabling personalized pathways, supporting formative assessment, and automating routine instructional tasks. Their analysis positioned AI not as a replacement for teachers, but as a supportive tool that amplifies professional expertise. Building on this, Luckin (2017) examined AI's potential in assessment, showing that while it creates opportunities for personalization and efficiency, it also requires careful integration to safeguard pedagogical values and teacher judgment.

A systematic review by Zawacki-Richter, Marín, Bond, and Gouverneur (2019) highlighted a key limitation in this emerging field: most AI initiatives in higher education (and not only might be added) were being shaped by technological priorities, with insufficient input from teachers in the design process. This imbalance raises important questions about teacher autonomy and the role of professional development in a rapidly changing educational landscape. Six years later, these concerns remain strikingly relevant. While awareness of the need for teacher involvement has grown and training opportunities are increasingly available, many AI systems continue to be developed with little pedagogical input. Teachers are more aware of AI's potential yet often feel unprepared or excluded from shaping how it is used, a situation that underscores the urgency of addressing teacher agency in the age of generative AI (OECD, 2024; Lim, Gottipati, & Cheong, 2023).

Against this background, recent empirical research has provided encouraging evidence of AI's applications in addressing learner diversity. Hooda, Rana, and Dahiya

(2022) found that AI-supported assessment platforms can generate timely and personalized feedback, thereby improving student performance and engagement in higher education contexts. Dagunduro, Chikwe, Ajuwon, and Ediae (2024) demonstrated that adaptive learning models can promote educational equity by tailoring content to the needs of individual students, offering a scalable form of differentiation. Similarly, Saleem, Aziz, Iqbal, and Abbas (2025) examined AI-based personalized learning systems and reported positive impacts on both engagement and achievement. What emerges from these findings is that AI offers a way to carry out differentiated instruction more widely and consistently than individual teachers could realistically achieve by themselves.

Beyond learning outcomes, AI has also been framed as a tool for enhancing inclusion and equity. Sathya (2024) highlighted the potential of adaptive learning ecosystems to foster social development by accommodating diverse learning profiles. Fitas (2025), in a study of AI for inclusive education, emphasized its role in supporting students with special needs and overcoming language barriers in multilingual classrooms. These perspectives align with broader policy-oriented analyses, such as the OECD (2024) report, which stressed that AI's impact on equity depends heavily on how issues of access, bias, and teacher preparation are addressed. Ethical concerns remain central to this idea. Lim, Gottipati, and Cheong (2023) approached these concerns and argued that without attention to fairness, accountability, and transparency, AI risks reproducing existing inequalities in educational assessment.

Despite this optimism, several scholars caution against viewing AI as a universal solution. Farrow, Iniesto, Pitt, Weller, and Bossu (2024) observed that the success of educational innovations depends as much on institutional culture, policy frameworks, and teacher knowlwdge as on the tools themselves. They note that while AI can contribute to addressing mixed abilities, its effectiveness ultimately hinges on how teachers are empowered to integrate it meaningfully within inclusive pedagogy. In this sense, I believe the question is not whether AI will replace teachers, but how teachers' roles will evolve alongside AI. As has been argued, it is not the technology itself that displaces educators, but the risk that those who fail to engage with it may find their practice increasingly out of step/date with the needs of twenty-first-century classrooms.

4. Methodology and Empirical Insights

4.1. Research Design

This study follows a conceptual-empirical design, combining a literature-based analysis with exploratory teacher input. Hence, it examines existing research on mixed-ability pedagogy and artificial intelligence in education, while the empirical strand introduces perspectives from Romanian teachers of English. The combination of these two approaches is particularly appropriate given the article's focus: to argue not only from

theory but also from the lived realities of educators who encounter mixed-ability classrooms daily.

A qualitative, descriptive design was chosen because the aim was not to produce large-scale generalizable claims but to generate context-rich and hands-on insights. Such an approach provides a nuanced understanding of the ways in which teachers interpret "mixed abilities" in their own classrooms, offering a practitioner's view that complements the more abstract discussions of AI's role in supporting differentiation and inclusion.

4.2. Participants

The participants consisted of 90 Romanian teachers of English, spanning primary, secondary, high-school, and university education. This range of contexts ensured that responses reflected not only differences across age groups but also across institutional settings and curricular demands. English language teaching provided an especially useful case for exploring mixed abilities, since English is often taught in heterogeneous classrooms where learners' previous exposure to the language, learning strategies, and external resources differ greatly.

This heterogeneity is amplified by structural features of the Romanian education system. Pupils often change schools when they transition from grade 4 to grade 5, especially in rural areas where village schools provide only the early grades and students must move to larger towns for further education. A similar situation occurs at the end of grade 8, when students enter high school, and again when they progress to university. While the national curriculum remains the same across grades 0 - 12, the differences in school environments, teacher expectations, and peer groups contribute to significant variation in students' prior knowledge and language competence. As a result, English language classes at each transition point tend to bring together learners with very different backgrounds, magnifying the challenges of teaching mixed-ability groups.

Teachers volunteered their participation during a professional training session in April 2025. The professional development setting created a context in which teachers were already reflecting on practice, making it more likely that their responses would be thoughtful and experience-based. Their collective voice provides a valuable view of how practitioners in one educational system currently conceptualize mixed abilities.

4.3. Data Collection

The data was collected using the online interaction platform *Slido*. Participants were presented with a single, open-ended question: *"What can 'mixed abilities' refer to in a class?"* They were asked to submit their answers anonymously using their mobile phone. When they registered for the workshop they were informed that the needed their fully charged mobile phone/tablet. The facility offered reliable and secure WI-FI connection.

This design choice was intentional. An open-ended prompt provided the flexibility for teachers to define "mixed abilities" in their own words, without constraints from predefined categories. The anonymity of the platform encouraged candid responses, enabling teachers to speak more freely about challenges they might hesitate to share in face-to-face interviews or group discussions.

The responses ranged from single-word entries (e.g., "motivation," "confidence") to longer reflections describing complex classroom dynamics. This variety illustrates the richness of teacher interpretations and shows how practitioners define mixed-ability education in layered ways, extending well beyond purely cognitive differences.

It should be noted that while 110 participants initially registered for the workshop, only 90 attended the face-to-face session. All attendees agreed to respond to the question, and they further consented to the use of their answers in this article.

4.4. Data Analysis

The data was analysed following the thematic analysis framework described by Braun and Clarke (2006). The analysis followed a process of repeated comparison, where each response was examined against earlier ones to refine and consolidate emerging themes. Five primary themes emerged:

1. Linguistic competence: Teachers frequently highlighted strong contrasts in vocabulary, grammar, and fluency.
2. Learning pace and cognitive processing: Many described differences in how quickly students grasp new content, recall information, or apply skills.
3. Motivation and engagement: A recurrent theme was the gap between motivated students who actively participate and disengaged learners who resist.
4. Socio-emotional development: Teachers noted inequalities in confidence, anxiety, resilience, and peer interaction.
5. Access to resources: Several responses emphasized differences in prior exposure to English and access to supplementary materials outside the classroom.

While these categories capture the major dimensions of mixed ability, teachers also pointed to structural factors, that exacerbate the challenge, such as large class sizes in urban schools and multi-grade teaching in rural areas. By structuring the responses in this way, the analysis shows that teachers perceive mixed ability as multi-dimensional rather than as a single trait. This complexity emphasises the challenge of designing instruction that can meet all learners' needs simultaneously and that these contextual realities indicate that mixed ability must be understood not only in terms of learner diversity, but also in relation to systemic conditions of schooling.

4.5. Empirical Insights from Teacher Perspectives

The teachers' responses vividly illustrate the reality of differentiation as labour-intensive work. For example, one respondent observed that while some learners progress "in leaps," others require repeated explanations and extra scaffolding. Another noted that "motivation is a bigger challenge than language itself," pointing to the affective side of mixed ability. Teachers also spoke of balancing the needs of highly advanced students with those struggling at the most basic level, a dynamic that can create tensions in classroom management and curriculum pacing.

A common thread was the sense that differentiation demands a constant cycle of material creation, adaptation, and adjustment. Several teachers expressed that while they valued the principle of inclusive pedagogy, the workload of trying to accommodate every learner often felt overwhelming. This duality, commitment to inclusivity paired with professional exhaustion, is a recurring theme in both practitioner testimony and academic research. In the Romanian state education system, where classes are typically assigned to a single teacher without the support of teaching assistants, the weight of responsibility falls entirely on the classroom teacher. This structural feature amplifies the challenge of managing mixed-ability groups, as teachers must address diverse needs single-handedly, balancing instructional planning, assessment, and emotional support without additional professional help.

The challenge is further compounded by class sizes, which in many Romanian state schools range between 25 and 35 students. The combination of large groups and the absence of additional classroom support creates conditions where differentiation becomes both essential and nearly impossible to sustain at the desired level. At the same time, the opposite situation can be found in rural areas, where the number of students is too low to justify assigning multiple teachers. In such cases, a single teacher may be responsible for pupils from different grades, such as 2nd, 3rd, and 4th, taught together in the same classroom. This multi-grade arrangement intensifies the complexity of mixed-ability education, since teachers must simultaneously prepare and deliver content across grade levels while still attending to individual learner differences.

Several teachers also remarked that the sustained effort required for constant differentiation can take a toll on their wellbeing, echoing broader concerns in the literature about teacher stress, burnout, and personal erosion in inclusive educational settings. These insights speak about not only the pedagogical but also the human cost of managing diverse classrooms without systemic support mechanisms.

4.6. Linking Empirical Insights to AI in Education

It is within this context that the potential contribution of artificial intelligence becomes most relevant. If teachers are tasked with continuously adapting content, monitoring learning pace, and engaging diverse levels of motivation, then AI can provide crucial support by automating aspects of this work. Adaptive learning systems, for example, can adjust exercises in real time to a learner's ability. Intelligent tutoring systems

can provide practice opportunities at different levels of complexity. Analytics platforms can monitor participation and progress, offering teachers actionable insights at a glance.

These technological supports allow educators to delegate the quantifiable and repeatable dimensions of teaching to AI, while retaining their energy and focus for the relational, interpretive, and creative aspects of pedagogy. In rural multi-grade classrooms, where a single teacher may need to instruct pupils across two or three grade levels simultaneously, adaptive AI platforms could be especially valuable by providing differentiated learning material aligned to grade-specific curricula. In such cases, AI has the potential to function not as a substitute for teacher expertise but as an indispensable assistant that ensures all learners receive appropriately levelled instruction.

This perspective suggests a transformation in the teacher's role: rather than devoting the entire school year to creating and modifying instructional materials, educators can embrace the position of AI-informed sense-makers. By working alongside AI, teachers are better placed to direct their professional expertise toward inclusive strategies that truly address the diverse needs of mixed-ability classrooms.

4.7. Synthesis

The synthesis of empirical and conceptual aspects points to an important conclusion: AI should not be understood as replacing teacher expertise, but as amplifying it. The Romanian teachers' responses highlight the multi-layered challenges of differentiation, which cannot realistically be managed by human effort alone. Meanwhile, the literature shows both the promise and risks of AI in education, emphasizing the need for careful, ethical, and pedagogically grounded integration.

When these perspectives are combined, a clear picture develops: teachers remain central to inclusive education, but their role is shifting. AI can take on some of the burden of repetition and standardization, enabling educators to act as reflective practitioners who interpret data, make nuanced judgments, and sustain human connection in diverse classrooms.

This argument is particularly compelling in contexts with large urban classes or rural multi-grade classrooms, where the demands of differentiation are intensified by systemic factors. By addressing these challenges, AI holds the potential to support teachers in delivering instruction that is both equitable and sustainable. Therefore, the challenge is not whether AI will replace teachers, but how teachers can harness AI to strengthen their professional development, autonomy, and creative impact in mixed-ability contexts.

5. Discussion

5.1 Rethinking Mixed-Ability Classrooms in the Age of AI

The findings from this study reaffirm that mixed-ability classrooms remain a defining reality of contemporary education, both in Romania and globally. Teachers in this study described differences in linguistic competence, pace of learning, motivation, socio-emotional

development, and access to resources as central dimensions of classroom diversity. These observations resonate with existing research, which similarly emphasizes that mixed-ability is a multidimensional construct rather than a single variable (Tomlinson, 2014; Blatchford et al., 2019). However, the testimonies of Romanian teachers further extend this picture by illustrating how structural conditions, such as large class sizes in urban schools and multi - grade classrooms in rural settings, exacerbate the challenges of differentiation.

This broader understanding of mixed ability suggests that inclusive pedagogy requires teachers to work across multiple layers of difference: not only individual learner variation but also systemic inequities rooted in school organization, resourcing, and geography. In such contexts, the principle of differentiation becomes both more urgent and more complex. Teachers in this study consistently voiced a tension between their commitment to inclusive practice and the exhaustion generated by the constant cycle of material creation, adjustment, and classroom management. Without additional support, differentiation risks becoming unsustainable, even for highly motivated and skilled practitioners.

It is against this backdrop that the potential contribution of Artificial Intelligence can be reconsidered. If mixed-ability classrooms are understood not simply as sites of diversity but as complex ecosystems shaped by individual, social, and structural factors, then the role of AI is not to replace teachers but to help them navigate this complexity. As Luckin (2017) and OECD (2024) argue, AI's capacity to provide real-time adaptation, predictive insights, and personalized content has significant implications for inclusive pedagogy. Yet what the Romanian case highlights is that AI should be deployed not in the abstract but in response to concrete challenges: supporting teachers who face thirty learners in one room without assistants, or those managing two or three grade levels simultaneously in rural schools.

By reframing mixed-ability education through this dual lens, combining global principles with local realities, it becomes possible to identify how AI might offer not just generic solutions but contextually responsive tools. This alignment between technology and lived classroom conditions is essential if AI is to move beyond rhetoric and become a practical resource for equity and inclusion.

5.2. The Transforming Role of the Teacher

The integration of AI into education inevitably raises questions about how the role of the teacher is redefined in mixed-ability classrooms. Historically, as stated before, differentiation has relied heavily on the ingenuity and resourcefulness of teachers, who were expected to design, adapt, and deliver materials to meet diverse learner needs (Tomlinson, 2014). While this approach reflects professional skill and commitment, it is also deeply labour - intensive. As classrooms become increasingly complex, whether through linguistic diversity, varied learning paces, or structural realities such as multi-grade teaching, the expectation that teachers alone can sustain this level of differentiation becomes less reasonable.

This perspective suggests, as before highlighted, a transformation in the teacher's role: rather than devoting the entire school year to creating and modifying instructional materials, educators can embrace the position of AI-informed sense-makers. In this capacity, AI is not a replacement for teacher expertise but a resource that handles the quantifiable and routine elements of teaching. Adaptive platforms, for example, can generate leveled reading texts or practice activities aligned to different proficiency bands, while analytics dashboards can flag students at risk of disengagement. The teacher's task then becomes interpreting these outputs, contextualizing them within the lived dynamics of the classroom, and embedding them into broader inclusive strategies.

Research in AI and education has highlighted a recurring tension: many systems have been designed from a technological perspective with limited input from educators, which risks overlooking the pedagogical subtleties of real classrooms (Zawacki-Richter, Marín, Bond, & Gouverneur, 2019). More recent work suggests that this is beginning to shift, with greater attention being paid to teacher agency and professional development in AI-supported instruction (Holmes, Porayska-Pomsta, Holstein, Sutherland, & Luckin, 2022). What remains clear and it was stated before, is that the value of AI lies not in replacing teachers' professional judgment but in amplifying it.

For Romanian teachers in particular, the sense-maker role is especially pertinent. In classrooms without teaching assistants, where one educator is responsible for groups of approximately 30 students in urban areas or multi-grade groups in rural settings, the ability to draw on AI for routine scaffolding could be transformative. Rather than becoming overburdened by endless cycles of material preparation, teachers could direct their energy toward fostering engagement, building inclusive relationships, and guiding learners through the social and emotional aspects of learning. In this way, AI has the potential to reconfigure professional practice: not as a threat to teacher identity, but as a means of sustaining it in increasingly demanding contexts.

5.3. AI as a Tool for Differentiation and Inclusion

One of the strongest findings of this study is that differentiation, while central to inclusive pedagogy, is also perceived by teachers as unsustainable when attempted without additional support. Here, AI offers promising opportunities by operationalizing differentiation at a scale that individual teachers cannot maintain alone. By leveraging adaptive learning systems, intelligent tutoring platforms, real-time analytics, and generative content tools, educators may be able to address the multiple layers of diversity present in mixed-ability classrooms more effectively.

Adaptive learning platforms are particularly suited to managing differences in cognitive pace and linguistic proficiency. For example, in a large urban class of thirty students, an adaptive reading platform such as MagicSchool (https://app.magicschool.ai/tools) or Flint (https://app.flintk12.com/) can assign levelled exercises tailored to each learner's

vocabulary range and comprehension ability. Rather than the teacher having to prepare three or four parallel versions of the same text, the system dynamically generates individualized pathways that converge on the same curricular goal. Teachers are then free to act as facilitators, guiding discussion, encouraging critical thinking, and supporting collaboration across ability levels.

Intelligent tutoring systems (ITS) further expand the possibilities for personalized practice. Tools such as *Write & Improve with Cambridge English* (https://writeandimprove.com) allow students to submit written texts and receive instant, automated feedback on grammar, vocabulary, and structure. In a Romanian high school English class, for example, weaker learners could focus on correcting grammatical errors while more advanced learners work on stylistic improvements, ensuring that each student benefits from individualized feedback. Similarly, a freemium platform like *Grammarly* (https://grammarly.com) provides sentence-level corrections and usage suggestions, enabling students to refine their language production at their own pace. These tools give teachers more flexibility, allowing them to dedicate time to higher-order concerns such as argumentation, creativity, and intercultural communication.

Real-time learning analytics can also play a crucial role in supporting student engagement and equitable participation. Several teachers in this study noted that motivational differences often overshadowed linguistic ability, with disengaged students posing a greater challenge than those who struggled with grammar or vocabulary. Platforms like Edpuzzle (https://edpuzzle.com) or ClassDojo (https://www.classdojo.com) allow teachers to monitor participation patterns and levels of engagement in real time. For instance, in a high school English class, Edpuzzle might reveal that a group of mid-level students consistently skips video segments, prompting the teacher to implement targeted strategies to re-engage them.

Finally, generative AI tools hold potential for easing the burden of material creation. Teachers repeatedly emphasized the constant cycle of adaptation and adjustment required to meet diverse learner needs. With AI-driven content generators, it becomes possible to rapidly produce alternative versions of exercises, quizzes, or even full lesson plans aligned to different proficiency levels or learning styles. Platforms such as Quillionz (https://quillionz.com), Socrative (http://socrative.com) and Curipod (https://curipod.com) enable teachers to create differentiated questions and lesson materials, while tools like ChatGPT (https://chat.openai.com) can generate levelled texts or discussion prompts tailored to students' needs. A teacher could, for example, prompt ChatGPT to produce simplified comprehension questions for weaker learners while generating inferential discussion prompts for more advanced students, both based on the same core text.

These applications align closely with the principles of inclusive pedagogy and adaptive assessment. AI-enabled assessments, whether formative or diagnostic, can provide immediate feedback tailored to each learner's level, enabling teachers to identify gaps and strengths far more efficiently than through traditional pen-and-paper tests. In this

way, AI does not just support individualized instruction but also creates new opportunities for equitable participation by ensuring that all learners, regardless of pace or starting point, have meaningful entry points into the curriculum.

The evidence from Romanian classrooms underscores the urgency of such solutions. Whether in crowded urban classes or small multi-grade rural schools, teachers face structural challenges that make differentiation increasingly difficult to sustain. By embedding AI thoughtfully into these contexts, educators can preserve their energy for the relational and creative dimensions of teaching while ensuring that learners receive instruction responsive to their diverse needs. Far from replacing teachers, AI thus has the potential to amplify their capacity to deliver inclusive, differentiated education in ways that are both pedagogically sound and contextually relevant.

5.4. Challenges and Ethical Considerations

Although AI holds significant promise for supporting differentiation and inclusion, it also raises important challenges. The OECD (2024) notes that while AI can enhance equity, it may also deepen inequalities where infrastructure and access are uneven. This is especially visible in Romania: many rural schools still face unreliable internet and limited devices, and with no teaching assistants in state classrooms, teachers bear the full burden of managing both instruction and technology.

Moreover, concerns about data privacy and bias are equally pressing. AI platforms rely on large volumes of learner data, which raises questions about ownership, consent, and protection. At the same time, language-focused tools may reproduce cultural or linguistic biases, inadvertently discouraging non-native speakers (Lim, Gottipati, & Cheong, 2023).

Finally, while AI is promoted as a means of reducing workload, teachers often worry it may initially create new pressures through training and troubleshooting. The key, therefore, is to frame AI as a supportive tool, with teachers remaining the sense-makers who bring professional judgment and human connection into mixed-ability classrooms.

6. Conclusion

This article has argued that artificial intelligence, if thoughtfully integrated, can play a significant role in supporting teaching in mixed-ability classrooms. The discussion has shown that while mixed-ability teaching is guided by long-established principles such as differentiation, inclusive pedagogy, and adaptive assessment, the sustainability of these practices remains a challenge for teachers working under real-world constraints. The empirical evidence from Romanian English teachers confirms this: although teachers recognize the value of inclusivity, many describe the workload of constant adaptation as exhausting, particularly in contexts where no teaching assistants are available or where one teacher is responsible for multiple grade levels in the same classroom.

Against this backdrop, AI offers tools that can help distribute some of the routine and quantifiable tasks of teaching. Adaptive platforms like MagicSchools or Flint, intelligent writing tutors such as Write & Improve, real-time analytics tools like Edpuzzle and ClassDojo, and generative AI platforms such as Curipod or ChatGPT demonstrate how differentiation can be better managed. These technologies do not replace teachers but allow them to assume the role of sense-makers, focusing their expertise on deeper aspect of teaching, interpersonal relationships, and the cultivation of inclusive classroom cultures.

At the same time, the challenges outlined in Section 5.4 make clear that AI is not a simple solution. Equity issues, especially in rural and under-resourced schools, remain a significant obstacle, while ethical concerns regarding privacy, bias, and professional autonomy must be addressed to prevent harm and preserve trust. Teacher professional autonomy remains central: if AI is to be successfully integrated, teachers must remain in control of how technologies are applied, trained in their pedagogical use, and supported institutionally rather than burdened individually.

The findings of this article thus support a nuanced position. AI should not be viewed as a disruptive force that will replace educators, nor as a neutral set of tools automatically leading to improvement. Rather, AI should be understood as a support for teacher's goals in the classroom: it can extend teachers' capacity to differentiate, personalize, and include, but only when situated within a supportive framework that values equity, professional development, and ethical responsibility.

Looking forward, further research is needed to deepen understanding of how free or freemium AI platforms can be adapted to local contexts, such as the Romanian education system, where structural limitations remain acute. Mixed-method studies combining teacher testimony with classroom trials could provide stronger evidence of both benefits and drawbacks. For practitioners, the immediate task is to experiment cautiously, integrating AI tools where they add value while maintaining a critical attitude toward their limitations. For policymakers and institutions, the responsibility lies in ensuring infrastructure, training, and ethical guidelines are in place so that AI supports rather than undermines inclusive education.

In conclusion, AI should not be seen as a threat to teachers, but as a resource to be exploited. Therefore, as insightfully observed before, the question is not whether AI will replace teachers, but whether teachers who do not engage with AI risk being replaced by those who do. The challenge, then, is not technological but pedagogical: how can AI be guided to support inclusive and differentiated teaching, instead of giving it the power to impose uniformity and standardization.

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Integrating AI Technologies in Inclusive Education Settings: Opportunities and Challenges

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The simultaneous development of education and emerging technologies has imposed an extensive integration of artificial intelligence (AI) tools within educational settings. In the realm of inclusive education, AI offers great support for both educators and their disabled learners by personalizing students' learning, reducing teachers' workload, giving quick feedback on students' performance and learning gaps with smart teaching systems, adapting learning content and objectives to students' special needs and paces, providing tailored support, enhancing accessibility, enhancing students' engagement and outcomes. However, an effective implementation of AI-driven systems in inclusive education settings, especially in developing countries like Morocco, might face various challenges such as limited funding, poor infrastructure, lack of both tutor and student training on the use of AI-powered assistive technologies, and parents' resistance due to their concerns about their children's data privacy and potential misuse. Hence, a number of measures should be taken in any mainstream school for an impactful and productive integration of AI in educating students with disabilities. These measures include allocating specific budgets for implementing AI in mainstream schools, looking for international partnerships, improving internet connectivity, providing both students and teachers with adequate continuous training on using AI technologies, and developing robust ethical standards to safeguard the students' data privacy. This paper presents a comprehensive review of the impact of AI on inclusive education settings, revealing both the benefits and the challenges related to its implementation.

Artificial intelligence; assistive technologies; educational accessibility; inclusive education; personalized learning; students with disabilities.

1. Introduction

As established by international frameworks such as the Convention on the Rights of Persons with Disabilities, inclusive education is regarded as a fundamental human right which calls for ensuring equal educational opportunities for all children regardless of their impairments (United Nations, Committee on the Rights of Persons with Disabilities, 2016). Within this context, it is understood that inclusion is based on adapting educational systems to overcome obstacles that hinder students' participation and learning opportunities. Thus,

inclusion fosters learning environments that embrace diversity and support participation of all learners, including those with disabilities in particular (Melo-López et al., 2025).

With the advancement in assistive technologies, AI tools have become vital in creating more inclusive and accessible teaching-learning environments for students with disabilities. Emerging studies, such as (Toyokawa et al., 2023; Sghaier et al., 2022), propose that AI can meaningfully improve students' equitable learning opportunities and active student engagement. In this regard, AI represents a promising means to remove obstacles to inclusion through promoting disabled students' accessibility, enhancing their learning personalization, ensuring quality instruction to meet diverse learners' needs, improving their participation in the classroom, and increasing their performance and grades (Melo-López et al. 2025; Yang, 2025). Not only this, but it can also ease and lessen teachers' workload, enabling them to allocate more time to creative teaching practices and effective pedagogical engagement (Zahurin et al., 2024). Moreover, Limna et al., (2022) highlight that artificial intelligence's capabilities such as generating predictions, delivering diagnoses, providing recommendations, and supporting decision-making, make it a fundamental component in the development of education. These abilities are perceived as highly pertinent and potentially beneficial within inclusive education settings, as argued in this paper.

Though AI represents a promising tool in ensuring more inclusive environment for students with disabilities, its implementation faces numerous challenges, especially in developing countries. These challenges encompass limited financial resources, underdeveloped digital and physical infrastructure, lack of professional training in the use of emerging assistive technologies for teachers and students (Yang, 2025), inequitable access to technology, families' resistance that stem from limited awareness, insecurity, or sociocultural beliefs about disability, information privacy, and technology (Prathama et al., 2022; Choez Calderón & Miranda Bajaña, 2024; Hong et al., 2018; Klimova et al., 2023).

2. Inclusion and its benefits for students with disabilities

According to UNESCO (2024), about 251 million children remain out of school across the world despite global efforts to ensure equitable education for everyone regardless of their impairments. This educational exclusion of children with disabilities excessively affects them and their families. In this regard, UNECEF (2021) also highlights that 49% of children with disabilities are more likely to have never joined school and 42% of them are less likely to acquire essential reading and numeracy skills in comparison to their nondisabled peers. Thus, it is necessary to provide disabled children with equal and equitable learning opportunities just like their non-disabled equals to fill in the gaps of both inequality and inequity in education between all these learners. This objective can only be achieved through a good implementation of inclusive education. Forlin et al. (2013) emphasize that inclusive education has the potential to enhance school enrollment and academic performance as well as other learning outcomes among students with disabilities.

Not only this, but we see that the benefits of inclusive education for children with disabilities can extend beyond academic achievement to their long-term integration into society and the job market. According to (National Center for Education Statistics, 2024), thanks to the implementation of the inclusive education approach, the number of students with disabilities who attended special education classes or benefited from related services was significantly increased by 3% in the 2022–2023 school year to reach a total of 7.5 million students in comparison to the prior academic year. This progress reveals the positive influence of the inclusive education model on the educational access and the learning opportunities of students with disabilities. Although all these benefits of inclusion, students with disabilities still might face various obstacles, such as those related to adequate adaptations of teaching practices to students' special needs (Kendall, 2016), those related to timely access to accommodations (Reed & Kennett, 2017), etc. This suggests that adequate pedagogical adaptations are highly needed to enhance students with disabilities' participation in the classroom, taking into account their individual impairments and learning needs. These adaptations include differentiated instruction, accessible materials, flexible pacing, etc.

3. The use of AI in modern education

The use of AI in education is defined as the integration of the intelligent technologies in the teaching-learning process, such as machine learning, deep learning, and other smart adaptive teaching systems, in educational settings. This is to help analyze and code huge amounts of data, interpret patterns, draw conclusions, personalize learning, and enhance instruction and learning outcomes just like human thinking and reasoning (Holmes et al., 2019).

The integration of AI tools in education has started emerging in numerous educational systems worldwide. Initially, the adoption of technology in modern education began with relatively basic digital tools like slide projectors, calculators, and word processors. This paved the way for the inclusion of more advanced technologies, like AI, in teaching. Nowadays, AI capabilities are being developed and comprehensively utilized to enhance the teaching and learning outcomes in schools. A key development in this regard is the establishment of AI adaptive learning materials tailored to the learners' individual attributes to provide them with the required knowledge and skills and target their learning needs based on their different abilities and paces. The integration of AI in designing such educational resources and materials would not only enhance the effectiveness of instruction, but would also ease educators' work (Spulber, 2024).

As declared in Safdar et al. (2024), AI has made a noteworthy progress in general education. Smart learning systems deliver knowledge and offer feedback to learners according to their learning progress and needs, while the learning management systems (LMS) identify the learners' actions and behavior to direct them to the adequate learning pathways. An example

of these technologies is the AI-assisted chatbots which can respond to students' inquiries and also provide them with adequate feedback and guidance on their work.

Furthermore, as discussed in Spulber (2024), artificial intelligence algorithms basically contributed to reshaping the foundational principles of the educational system, notably leveling up education quality. AI offers a great support for both teachers and students. On the one hand, AI support for teachers can be seen in personalizing teaching, providing didactic materials, etc. On the other hand, AI can support students through offering intelligent tutoring tools, personalized programs, assessment, feedback, etc (Holmes and Tuomi, 2022; Spulber, 2024). Thus, for both teachers and students, AI can accelerate the teaching process and make it more effective and productive; It can analyze student-related data, such as prior knowledge, individual preferences and intelligences, learning styles, and learning gaps, in order to tailor the efficient instructional strategies that meet the characteristics of each learner (Lokare and Jadhav, 2024; Spulber, 2024).

AI can help teachers create diverse and personalized materials for their students if used appropriately to generate texts, assignments, questions, and other teaching content, which are personalized to students' knowledge and proficiencies. AI also serves different purposes, including homework personalization, assessment, accessibility, and inclusion. It can be used to accurately evaluate students' performance, monitor their progress through assignment analysis, and provide them with purposeful personalized feedback. Not only this, but AI is also useful in learning translation techniques and understanding foreign languages, especially in multilingual education contexts Spulber (2024). Furthermore, promoting inclusive education is one of the most essential contributions of AI in modern education. It enhances accessibility through offering tools that accommodate students with diverse needs, it improves personalized learning, and it eases teachers' work. This plays a vital role in ensuring more inclusive environment for students with disabilities (Spulber, 2024; Yang, 2025; Safdar et al.,2024; Melo-López et al. 2025; Fitas, 2025; Yang and Taele, 2025; Julien, 2024; Toyokawa et al., 2023).

4. AI impact on inclusive education settings

As understood from what is discussed above, AI and assistive technologies are advantageous in ensuring more inclusive environments for students with disabilities. They play a vital role in enhancing quality and equity in inclusive schools. These two key elements of inclusive education can be significantly achieved through the integration of AI tools (e.g., predictive text, chatbots, intelligent tutoring systems, etc.) and assistive technologies (e.g., braille displays, screen readers, hearing aids, etc.) into the teaching-learning process for students with disabilities. As discussed in Spulber (2024), the impact of these tools and technologies on inclusive education settings can be seen in reduced teacher workload, improved accessibility through assistive technologies, and personalized learning, all of which contribute to increased academic success and performance, stronger

emotional bonds between teachers and students, and greater motivation and engagement necessary for inclusion.

4.1. Enhancing student personalized learning

The integration of AI in inclusive education settings has a positive impact on personalized learning of students with disabilities. For instance, Tuna (2022) highlights the effective role of humanoid robots and virtual agents in supporting personalized learning for students with Autism Spectrum Disorder (ASD), which also help educators easily plan their activities and interventions. This can also be confirmed by Spulber (2024) who found that AI can significantly enhance personalized learning through both content adaptations to the specific needs of students and given quick feedback with smart tutoring systems.

Furthermore, as stated in Yang (2025), personalized learning is beneficial for students with disabilities as AI tools can compare students' prior and current performance data and analyze it to predict their areas of strengths and weaknesses. This, in turn, leads to easily specifying each special learning problems and needs, their appropriate placement, their learning goals as well as the required classroom adaptations and adequate teaching methods to address the diverse learning gaps and obstacles of these students.

As the role of educators in delivering content has been transformed from traditional ways to more facilitative and personalized teaching strategies and methods that cater for all individual learning requirements of all learners, AI technologies, like adaptive learning platforms and intelligent tutoring systems, are effective in personalizing teaching and learning experiences for the benefit of students with diverse disabilities. These technologies can analyze learners' data and adequately tailor teaching content to their special learning needs and pace, allowing more time for educators to establish more creative learning experiences for students and focus on each learner's individual needs and areas of weaknesses to be developed (Fitas, 2025).

Hence, we can conclude that AI-powered technologies, by personalizing the learnings of students with disabilities, also have positive impact on teachers' work. They ease and reduce educators' workload, free up their time, and allow them to be more creative and tailor effective teaching plans that better serve each student's specific learning needs.

4.2. Reducing and easing teacher workload

As AI represents a promising tool to enhance customized learning for students with disabilities and provide quick feedback on their performance, it helps them identify areas for improvement and also guides inclusive teachers in adopting more interactive approaches tailored to students' needs and learning styles. This, in turn, enhances motivation and participation among students with disabilities (Julien, 2024). With a comprehensive and varied understanding of AI tools, teachers can efficiently identify and address the diverse learning needs of students with disabilities. In addition to staying up to date with the different AI tools, teachers can better ensure accessibility and inclusivity for

their students when they well understand how these tools can be practically applied in the classroom (Becker et al. 2018; Julien, 2024). Educators can also contribute to the development of AI-powered tools according to the needs of their students with disabilities to improve their instructional practices and successfully support and engage all students (Julien, 2024).

Baidoo-Anu and Owusu Ansah (2023) argue that artificial intelligence can support educators in recognizing the different learning gaps of their disabled students and identify the styles through which every individual learner learns the best, which allows them to tailor appropriate interventions and successfully meet the learning needs of all students. AI is gradually reshaping education in our modern era by guiding teaching and learning and enabling both students and teachers to adapt to this gradual development. For instance, as highlighted in Julien (2024), AI-powered EdTech tools can quickly and effortlessly gather and analyze data, and prepare reports, enabling teachers to assess the status of students. This facilitates continuous evaluation of students' performance, discover their areas of weakness and strength, offer focused and valuable feedback to both students and teachers, and also recommend resources to further development of teaching and learning. Furthermore, AI can not only be used in achieving teaching and learning goals, but can also take part in accomplishing various tasks assigned to administrative and information technology staff; in addition to tutoring, artificial intelligence would be influential in scheduling, managing data, and grading (Julien, 2024).

Integrating AI in inclusive education has become an indispensable necessity, for AI can be a helpful tool for better teaching, better learning, tailored instruction, personalized learning, accessibility, and time saving. AI can significantly help teachers with grading, students' performance analysis and assessment, as well as lesson planning. Thus, teachers gain valuable insights into their students' needs, struggles, and areas to be addressed. Subsequently, educators can opt for creative tasks, and tailored activities and lessons that would enhance students' performance and boost their accessibility. Additionally, AI can reduce the workloads burden on educators as it spares them the repetitive administrative tasks, such as reports, data summary and data entry. This, in turns, allows teachers to focus more on classroom practices and students' interaction. Moreover, it has been proven that AI-powered lesson planning can equally save teachers' time and provide differentiated activities and tailored tasks to suit each student's unique disability. This ensures adaptability, accessibility, and inclusivity (Fitas, 2025).

In the same flow with all the aforementioned studies that discussed the key benefits of AI-powered tools on educators, other studies such as (Toyokawa et al. 2023 ; Safdar et al.,2024; Melo-López et al. 2025) also highlight that AI tools can transform teachers' support and professional learning in the context of inclusion, help teachers more develop their instructional and organizational practices to better support all students, and reduce teachers' burden and workload in busy classrooms through providing feedback on

students' personalized learning needs and progress. This, in turn, allocates more time for teachers and facilitates their interventions and reflections to better deal with every learner.

As we discussed earlier, AI-driven technologies play a vital role in personalizing learning for students with disabilities while also facilitating and reducing teachers' workload. Consequently, these two factors effectively enhance students' accessibility to learning materials and content, thereby promoting their inclusivity and improving their learning outcomes.

4.3 Enhancing student accessibility

Using AI technologies in inclusive education is one of the best strategies to bridge the gaps between students with disabilities and their access to learning materials. By bringing AI tools and inclusive education principles together, they can help in making learning environments more inclusive for students with diverse special needs, which supports their learning progress. Some educational institutions already developed certain AI systems to promote inclusive education, enhance disabled students' access to learning, and increase their performance and grades. For instance, Toronto University created a platform called "ATutor", one of the first accessible e-learning systems designed for students with visual impairments, whereas the university of Iraq established "LAYA Iraq" **(**learn as you are), an AI-powered learning management system (LMS) designed with a strong focus on accessibility and inclusivity for users with different impairments, especially those with reading and cognitive disabilities (Yang, 2025). Moreover, as stated in Yang (2025), Wood (2019) revealed that using new emerging AI-driven technologies can better enhance accessibility and improve educational development of students with chronic conditions. Furthermore, Batanero et al. (2019) highlight that when the learning content is adapted to the unique needs of students with disabilities and integrated into AI-driven teaching platforms, the learning outcomes of these students remarkably improved. Namely, the progress of visually impaired students increased by 45%, students with hearing impairment by 46.25%, and those with both visual and hearing impairments by 87.5%. This underline the potential of AI-powered educational platforms to foster inclusivity, accessibility, and educational attainment among students with diverse learning needs.

Yang and Taele (2025) state that AI-driven platforms like Audemy enhance accessibility for students with disabilities, especially blind and visually impaired students. They allow them to interact with digital content via adaptive questioning platforms, screen readers, and speech-to-text applications, and audio-based customization. Intel-powered AI personal computers also contribute to improving accessibility for blind and visually impaired students through enabling private processing, handling ethical data, and reducing privacy risks.

Other studies stress the importance of AI technologies in promoting disabled students' accessibility to learning content and materials as well as improving their

engagement in the learning process in inclusive classes. For instance, Patiño-Toro et al. (2023) emphasize the pivotal role of Massive Open Online Courses (MOOCs), designed for deaf students, in overcoming these students' barriers to communication and expanding their equitable access to higher education. Toyokawa et al. (2023) also highlight the positive impact that AI tools can have on disabled students' active reading through real time determination of their learning strengths and weaknesses, which assist educators in tailoring teaching content and methods to their specific needs. Moreover, Kamber, (2025) confirms the necessity of AI tools in enhancing student accessibility, especially in higher education. He believes that AI technologies like text-to speech and speech recognition systems, play a significant role in improving student accessibility and academic success, which also promotes social justice and equitable education for students with disabilities.

The integration of AI tools in inclusive education and their benefits on students with disabilities are also discussed in Safdar et al. (2024). They agree that text-to-speech and speech-to-text applications can help students who have writing difficulties or students who can better understand through audios like dyslexic and visually impaired students. They also stress the role of technologies in computer vision to assist blind or visually impaired students in describing images and pictures, while the integration of augmented and virtual reality systems in educating students with disabilities, particularly those with attention disorders, can enhance their learning experience and improve their academic achievement. Moreover, the study sheds light on the potential benefit of AI-driven emotion recognition tools on leveling up the social skills of students, especially those with social and emotional learning difficulties. Not only this, but also AI-powered real time language translation and natural language processing tools can effectively assist students with language disorders and non-native students in having accessibility to learning and easily integrating with other students in an inclusive class. In the following section we shed light on the different AI-powered assistive technologies and their potential benefits on students with disabilities as discussed in Fitas (2025).

4.4 Enhancing inclusivity through AI-driven assistive technologies

Given that students with diverse types of disabilities encounter different challenges in their learning process, AI and its powered assistive technologies have proven their vital role in transforming educational strategies in supporting the varied special needs of these students (Yang, 2025; Fitas, 2025). As illustrated in the diagram below by Fitas (2025), this section sheds light on different AI-driven technologies and discusses their educational applications and benefits on students with diverse disabilities.

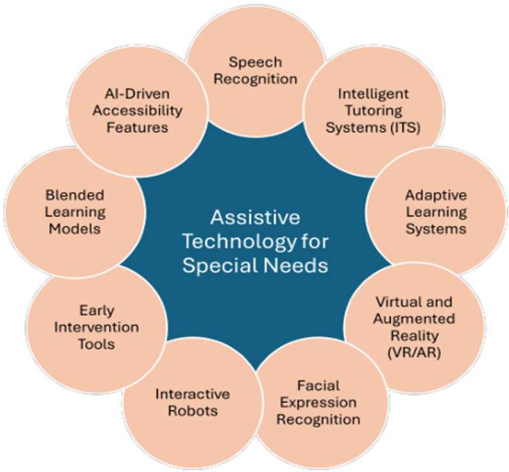

Figure 1: Visualization of all the mentioned categories of assistive technology for special needs (Fitas, 2025, p. 13)

4.4.1. Intelligent tutoring systems (ITS)

Intelligent Tutoring Systems (ITS) are AI-powered tools that help teachers and disabled students, especially those with dyslexia and dyscalculia, personalize learning. ITS also take part in adapting students' learning to their unique styles and pace as well as providing real-time feedback and tailored resources. For instance, ALEKS (assessment and learning in knowledge spaces) and Q-interactive platforms improve learners' engagement by adapting content difficulty based on students' responses. Powered by AI technologies, such as natural language processing (NLP) and machine learning, ITS deliver personalized feedback, explanations, and formative assessments to ease learning, and support accessibility and independence for disabled students. Thus, ITS encourage adaptability, inclusivity, and evidence-based education (Fitas, 2025).

4.4.2. Speech recognition tools

By converting speech to text and vice versa, speech recognition and synthesis tools such as Speech-to-Text (STT) and Text-to-Speech (TTS) ensure accessibility for students with visual, reading, speech, and hearing disabilities. For visually impaired and reading-challenged students, TTS support them by raising content comprehension through effectively and intelligibly turning text into natural-sounding speech. STT can accurately transcribe spoken language into texts, enabling students with speech impairments to efficiently interact with teaching content. AI tools like Stamurai can offer speech therapy support and enhance personalized learning and accessibility experiences for students with disabilities, while augmentative and alternative communication (AAC) devices and automated captioning systems would meaningfully promote classroom participation.

Moreover, AI integration in AAC technologies would further boosts their functionality, supporting independent learning and personal growth of students (Fitas, 2025).

4.4.3. Adaptive learning systems

Adaptive learning systems, driven by AI and machine learning, offer customized learning through ongoing assessment of students' performance and adapt learning materials to the students' special needs and diverse learning style. Carnegie Learning, DreamBox, and Notebook platforms are examples of adaptive learning systems that can be applicable to subjects like maths and reading activities. Compared to traditional learning models, adaptive learning algorithms offer real-time feedback, predictive analytics, and dynamic content adaptations to enhance students' participation, accessibility, performance, accessibility, and inclusivity (Fitas, 2025).

4.4.4. Virtual and augmented reality (VR/AR)

The integration of virtual and augmented reality (VR/AR) technologies in inclusive education offers engaging learning environments similar to real-world situations, especially for students with autism spectrum disorder (ASD), as they ensure a safe and monitored environment to support social interactions and enable students to manage complex settings. For instance, VR supports social, cognitive, and linguistic skills, while offering engaging and adaptable experiences that traditional therapies often fail to provide for students with ASD. Additionally, AR tools, such as Augmenta1 1y application, help learners with dyslexia by providing content in accessible formats to respond to diverse needs and make education more inclusive. Other AI-integrated tools, such as Google Glass and Lexplore, can further support personalized learning experiences as they assist students with reading and social challenges (Fitas, 2025).

4.4.5. Facial expression recognition

The use of AI-powered facial recognition technologies in inclusive education settings support students with Autism Spectrum Disorder (ASD), for they can detect their emotional states as well as their social and communication challenges, enabling educators to appropriately respond to them. AI-driven tools that integrate Internet of Things (IoT) abilities and emotional intelligence algorithms, such as those using Haar-cascade Python libraries, Convolutional Neural Networks (CNNs), can identify real time facial expressions and emotions and control stress levels of students with ASD through Galvanic Skin Response (GSR) sensors. This, in turns, enable educators to offer timely personalized support and interventions, which would improve social participation and engagement as well as interactive competencies and skills these children. Moreover, Human-Robot-Game platforms also have been developed to raise facial recognition metrics, offering adequate assessment of emotional reactions of students with ASD and measuring their socio-educational progress. Though barriers like overfitting and the need for improved

generalization might persist, certain emotion recognition systems using deep learning, such as Visual Geometry Group-16 (VGG-16) and Residual Network-18 (ResNet-18), can efficiently help classify students' emotions and insightfully foster supportive learning environments (Fitas, 2025).

4.4.6. Interactive robots

Integrating interactive robots in inclusive education settings would emotionally and educationally support students with physical and cognitive disabilities. These AI-generated robots use features like gestures analysis, speech recognition, and customized feedback mechanisms, to develop accessible and engaging learning experiences for disabled students, especially those with neurodevelopmental disorders. For instance, the Sahayak app combines AI and augmented reality to personalize learning experiences to the unique needs and styles of students with intellectual disabilities, improving their reading and comprehension skills through interactive elements. Other educational robots, like Emorobot, enhance social skills in autistic learners via emotions recognition peer interaction simplification (Fitas, 2025).

4.4.7. Early intervention and diagnostic tools

Artificial intelligence-driven diagnostic tools have notably enhanced early detection and intervention practices for learning disabilities and developmental challenges through the use of machine learning algorithms to adequately examine student progress and behavior and accurately identify challenges related to certain disabilities like dyslexia, dyscalculia, ADHD (attention-deficit / hyperactivity disorder), and autism spectrum disorder (ASD). AI-powered platforms can track students' struggles and provide timely and personalized intervention strategies tailored to the students' needs, while the integration of multi-sensory technologies in diagnostic systems can assess cognitive, motor, and social skills of students, which would efficiently help in customizing adequate interventions to enhance developmental progress. Early AI-driven diagnosis is beneficial for students with dyslexia and autism spectrum disorder, as it can reduce the impact of the disorder on students' educational attainment, social interactions, psychological dimensions (Fitas, 2025).

4.4.8. Blended learning models

Blended learning models that utilize traditional methods combined with AI-powered technologies boost inclusive and flexible educational environments for students with disabilities; they address diverse learning needs, foster learning engagement, and ensure accessibility and participation for all students. Moreover, the integration of AI with Universal Design for Learning (UDL) model has the potential to effectively surpass traditional models in improving the educational outcomes of students with disabilities, ensuring their learning accessibility and personalization. AI-driven hybrid learning models

improve learning engagement, participation, and autonomous learning in both in-person and virtual classes, which in turn enhances academic performance. In blended learning settings, using AI through strategies like gamification and customized learning pathways has revealed significant educational progress. For example, a study conducted in Shanxi, China, stated that students' vocabulary acquisition improved by 25%, while their reading comprehension skills increased by 30%. Furthermore, combining AI with the principles of multiple intelligences theory strengthens personalized instruction, fosters learning performance, and enhances problem-solving competencies and creativity (Fitas, 2025).

4.4.9. AI-driven accessibility features

Boosting learning independence and inclusivity for students with disabilities are key aspects of how AI-driven accessibility features are transforming modern education. Technologies like image recognition, customizable interfaces, and real-time translation accommodate diverse learning needs through adapted learning environments. For instance, AI-driven braille devices support learning independence for students with visual impairments, while automated captioning systems and text-to-speech converters assist students with visual or hearing impairments in having access to educational content. Moreover, AI-advanced features, like speech and emotion recognition, support SWD (students with disabilities) in inclusive education settings by improving their communication proficiency and user satisfaction. Other tools, such as navigation, object detection, and optical character recognition (OCR), can guarantee navigation safety and information accessibility for students with visual impairments. Furthermore, adaptive learning systems and AI-driven chatbots would also contribute to personalized learning and timely interactive communication, while AI-powered multisensory systems can bridge accessibility gaps for students by providing adaptive feedback through the integration of visual, auditory, and tactile sensory modalities in their learning process (Fitas, 2025).

5. Challenges of integrating AI in inclusive education settings

Despite the benefits of AI-powered technologies on students with disabilities, numerous potential challenges might face the productive implementation of these technologies in inclusive education settings. These include limited funding, lack of infrastructure, lack of teacher and student training, and families' concerns about their children's data privacy and its potential misuse. In this regard, studies like (Spulber, 2024; Yang, 2025; Melo-López et al. 2025) highlight that an effective adoption of AI tools in educating students with disabilities require adequate funding, infrastructure availability, and adequate preparedness of both teachers and students. Without adequate resources and professional development of educators, AI impact on inclusion remains restricted. Moreover, as stated in Yang (2025), some learners can have more than one disability while certain AI systems can only meet one special need. This, in my opinion, requires adequate funding as well as training for teachers to adopt or develop AI educational systems that can meet these learners' different special needs to extend their education accessibility and engagement.

Safdar et al. (2024) also discuss the aforementioned challenges. Their study emphasizes that under resourced schools might face the problem of AI systems unavailability, which can also lead to some gaps in students' educational achievement. In addition, they shed light on the problem related to students' privacy and data ownership, which should be addressed to protect the information collected about these students, their disabilities, characteristics, and behaviors. Another challenge is that AI can be biased and treat students unfairly, misjudging their abilities, race, gender, social status, or disabilities. Moreover, some AI systems might not be transparent, and it is hard for their users to know how these systems make decisions. This, in turns, make them untrustworthy for teachers, students, and parents. Furthermore, the study highlights the challenge of overreliance on AI and its negative impact on students with disabilities, especially those with social and emotional learning difficulties and those who need direct human interaction, which requires building a balance between AI use and teacher-student interaction.

AI cannot replace teachers because it lacks human consciousness, emotions, and awareness, which makes it unable to understand complex human experiences and fully match their intelligence and creativity. In addition, AI can only depend on data input to produce an output, which means that the accuracy of AI's generated information is conditional upon the accuracy of the information provided to it. This can lead to biased and destructive learning. The study also tackles other challenges such as overreliance on AI technologies and its negative effect on critical thinking and problem solving skills, the high cost of AI systems, the potential physical harm (headaches, fatigue, etc.) of using AI technologies, students' data privacy and security concerns, curriculum perpetuated bias, and lack of teachers' and students' pre-training (Julien, 2024).

Excessive reliance on AI also raises concerns about over-automation, which restricts direct human interaction in inclusive education settings. Thus, AI should only complement the human pedagogical engagement rather than replacing it, which keeps the meaningful teacher-student interaction. In addition to this, productive implementation of AI-driven technologies requires the investment in infrastructure and teacher training and student, particularly in underprivileged countries (Melo-López et al., 2025).

All in all, due to challenges such as complexity of technology development, digital infrastructure gaps, ethical considerations, potential biases, inequitable access to learning, data privacy concerns, and lack of training of both teachers and students, AI-powered technologies must be implemented thoughtfully and with cautions in inclusive schools (Fitas, 2025).

6. Conclusion

AI integration in inclusive education settings has a significant impact on students with disabilities. AI-driven assistive technologies can efficiently personalize students' learning and give quick feedback on their strengths, weaknesses, and learning gaps. Not

only this, but it can also suggest adequate methods and strategies to overcome their learning obstacles and enhance their academic achievement. This, in turn, supports educators by reducing their workload and allowing more time for them to design effective plans and interventions tailored to the different needs of students. Furthermore, by personalizing students' learnings, analyzing their performance, and identifying their learning struggles, AI-powered technologies can also provide adapting learning contents and objectives to the special needs and paces of students with disabilities, thereby improving their inclusivity and accessibility, supporting their engagement, and enhancing their learning outcomes.

However, the implementation of AI in educating students with disabilities may encounter numerous challenges including lack of funding, inadequate infrastructure, concerns about data privacy and potential misuse, overreliance on AI, biased treatment of students, and lack of adequate training for both students and educators. Thus, several measures are required including allocating adequate budgets for the implementation of AI-powered technologies in inclusive schools, improving internet infrastructure, establishing international partnerships, developing robust ethical frameworks to protect students' data privacy, and offering adequate continuous training on the use of AI-driven technologies for both students and educators.

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AI Tools for Academic Research, Writing and Translation

Leveraging AI-Powered Tools in Academic Research: Promises and Perils

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Artificial intelligence (AI) is rapidly reshaping scientific research through a range of powerful tools that may very likely enhance data analysis, modelling, and discovery across disciplines. In fact, the integration of AI-powered tools into academic research is quickly overriding traditional methodologies, which offers enhanced efficiency, scalability, and analytical capabilities. This article critically examines both promises and perils associated with the use of artificial intelligence in scholarly work. On the one hand, the transformative potential of AI facilitates rapid literature reviews, helps with data analysis by uncovering patterns in complex datasets, and, hence, accelerating the work flow in the research process. On the other hand, AI raises pressing concerns among academia around data privacy, lack of transparency, ethical dilemmas surrounding data use and authorship attribution, besides the potential erosion of academic rigor. This paper further highlights how dependence on AI may impact critical thinking and scholarly originality while at the same time recognize access to research tools and foster interdisciplinary collaboration. Through a balanced analysis of current applications, case studies and ethical considerations, this paper will provide practical guidelines for the responsible integration of AI in academia. By doing so, this paper contributes to the ongoing discussion on aligning technological innovation with the core values of academic integrity. Actually, it is meant to encourage academics to think critically about how to responsibly leverage AI technologies in scientific research meanwhile ensuring that scientific rigor, human oversight, and ethical standards remain central to scholarly work. The goal is to foster informed, cautious, and effective use of AI-powered tools in advancing scientific knowledge.

Artificial Intelligence; AI-powered tools; academic integrity; ethics, scientific research.

1. Introduction

Today's world is witnessing an unprecedented digital transformation, with artificial intelligence (AI) technologies at the forefront. Thanks to the massive advancements in computer and machine learning, AI has invaded various fields, including education and scientific research. In fact, AI-powered tools are among the most influential innovations in

academic practices, contributing to enhancing research quality, accelerating access to information, analyzing large sets of data, and automating certain complex research tasks. Despite the numerous opportunities these tools can offer, their excessive use raises fundamental questions related to scientific rigor, algorithmic bias, academic ethics, the potential for plagiarism, and the possible impact on researchers' cognitive and analytical skills. This article aims to explore the use of AI tools in academic research from two main perspectives: the promises they hold in enhancing research efficiency, and the risks that may arise from their misuse or lack of regulation. In the following sections, the defintion of AI and its development in the academic context will be reviewed. Besides discussing how different AI-driven tools are applied and what benefits can offer to researchers, there will be a critical analysis of the challenges and drawbacks that accompany their use. The article will also present some case studies to illustrate the potential benefits and the limitations of these AI tools when used in research along with practical recommendations to promote the safe and effective use of AI in academic research.

2. The definition of artificial intelligence and its emergence in the academic context

Artificial intelligence focuses on creating systems that can perform tasks which typically require human intelligence, such as learning, reasoning, and problem-solving. Recently, its emergence in academia has been marked by its rapid adoption in different disciplines, leading to a dramatic shift in research methods, educational tools, and scholarly work. Actually, it is undeniable that AI has incredibly exhibited an ability to process large amounts of information and generate insights, which has made it a powerful asset in academia, prompting both excitement and critical reflection on its implications for knowledge creation and academic integrity.

2.1. Definition of artificial intelligence

To start with, the concept intelligence can be defined as the capacity of a human being to acquire, manipulate and transform new information, besides critically evaluate processed data, identify patterns and relationships, interpret meaning, and distinguish between facts and beliefs. In the same way, artificial intelligence (AI) can mimic these cognitive functions through designing algorithms and providing structured data to computational systems (Mueller & Massaron, 2018).

Concerning the definition of artificial intelligence, different scholars define it in different ways depending on their disciplinary perspectives. For instance, AI, a term introduced by John McCarthy in 1955 (Cristianini, 2016), refers to a broad set of tools and techniques that enable computers to perform intelligent human tasks like analyzing, reasoning, and decision-making (Nilsson, 1998). Thus, artificial intelligence embrace methods, processes, and technologies that

allow systems such as machines, robots, or software to interpret large volumes of data and learn from it, with the goal of emulating specific human cognitive abilities (Di Vaio et al., 2020). Popenici & Kerr also refer to AI as "computing systems that are able to engage in human-like processes such as learning, adapting, synthesizing, self-correction and the use of data for complex processing tasks" (2017, p. 2).

All these definitions agree that AI is a branch of computer science which aims at building systems capable of imitating human intelligence, including the abilities to learn, analyze, make decisions, and interact with different contexts. This concept has evolved since the mid-20th century, passing through various stages starting from simple rule-based systems to deep learning and generative models such as ChatGPT or Gemini. Therefore, the rapid progress of AI has the potential to drive radical changes across multiple disciplines, including academia.

2.2. The emergence of artificial intelligence in the academic context

The role of artificial intelligence in academia started modestly in previous decades, but it grew rapidly with the rise of the internet and advanced computing technologies. Early applications included basic tools like grammar checkers and machine translation. However, today AI has greatly evolved and became capable of performing far more complex tasks, such as analyzing academic texts, suggesting relevant references, helping researchers brainstorm or even draft initial versions of their work, and processing both qualitative and quantitative data with greater efficiency. Hence, AI has significantly transformed academia, reshaping how research is carried out, knowledge is produced, and education is delivered. By integrating AI tools, academic institutions can streamline the workflow, improve research efficiency, and encourage innovative practices. A key area of impact is data analysis since AI allows researchers to process large datasets quickly and accurately, and hence uncover patterns, and relationships that might be difficult or time-consuming to detect using traditional methods (Brynjolfsson & McAfee, 2011; Hui, 2020). Artificial intelligence is also revolutionizing the process of research as a whole. It has significantly transformed the realm of academia, serving as a driving force behind methodological shifts and broader changes in scholarly frameworks (Pal, 2023). Its transformative impact is clearly reflected in various disciplines. This allows researchers to tackle complex tasks on a scale that was once beyond imagination. For example, AI supports researchers by automating tasks like literature reviews and knowledge synthesis, and efficiently scanning and extracting key information from a large number of scientific papers. This not only streamlines the research workflow, but it also enables researchers to keep pace with the latest developments in their disciplines. Moreover, artificial intelligence has the potential to enhance researcher capabilities in academia (Popenici & Kerr, 2017; Williamson & Eynon, 2020). By automating repetitive tasks, it allows researchers to dedicate more time to higher-level cognitive work. This includes streamlining processes such as data collection

and analysis, and even helping with manuscript editing. As a result, researchers can focus more on critical thinking, generating hypotheses, and exploring new paths of research. Therefore, the role of artificial intelligence (AI) in academic research goes far beyond basic technological enhancement; it represents a significant methodological shift, providing promises and potential benefits to improve the quality of academic research and accelerate its process.

3. The promises and potential benefits of artificial intelligence in academic research

In recent years, there has been a remarkable transformation in researchers' performance thanks to AI-powered tools, which have increasingly played an important role in improving the quality of academic research and facilitating the various stages of its process. This section highlights the most prominent promises and potential benefits these tools can leverage in the academic context, how they can enhance research efficiency, and open new horizons for creativity.

3.1. Accelerating the research process and enhancing data analysis

One of the most notable promises of artificial intelligence in academic research is speeding up the completion of research tasks. Processes such as literature reviews, data collection and analysis - previously requiring months of manual work - can now be done within days thanks to AI literature review assistants, such as Litmaps, Elicit, Connected Papers, or Research Rabbit, which rely on algorithms that track patterns and connections among research papers, helping to discover sources that may not appear in traditional search engine results. These AI tools are both effective and efficient in conducting detailed content analyses, detecting emerging trends, and identifying gaps within existing research (Burger et al., 2023; Nguyen-Trung et al., 2023; Müller et al., 2022; Tauchert et al., 2020).

Researchers also need powerful tools to analyze data, so AI-powered platforms like IBM SPSS, NVivo or Atlas.ti provide great help in this regard. Theses tools rely on algorithms trained on large amounts of data that enable them to detect subtle patterns and predict relationships that human researchers might overlook (Burger et al., 2023; Nguyen-Trung et al., 2023). This is especially useful for analysing large sets of data, detecting biases or repetitions, and identifying thematic categories in qualitative studies. Moreover, avoiding personal judgments during statistical analysis is a significant advantage, as these tools, unlike human beings, can deliver neutral and objective results free from human biases and subjective evaluations. With regard to accuracy of data analysis and results, AI provides innovative tools which enrich methodology, and enhance the efficiency and accuracy of data analysis (Wang et al., 2023). This accelerated pace in the research process provided by AI not only shortens time, but it also contributes to increased scientific

production, which allows researchers to conduct more studies or improve the quality of their work.

3.2. Supporting academic writing and improving text quality

Another benefit of AI tools is their capability to improve the linguistic structure of academic texts, suggest more precise and consistent language structures, detect repetitions or ambiguities in human-produced texts via tools such as Grammarly or Quillbot. These tools analyze texts, detect grammatical and spelling errors, and improve writing style to fit academic language. This is particularly helpful for non-native English-speaking researchers aiming to publish in international journals. Tools like ChatGPT, or Wordtune provide multiple phrasing alternatives for the same idea, which enhances language quality and accuracy. In fact, These tools enhance language expression and ensure adherence to academic writing standards in research. Beyond offering suggestions and corrections to improve writing quality, they can also identify areas needing improvement and deliver timely feedback. Additionally, these AI tools assist in organizing longer, more complex articles to improve clarity and readability (Archibald & Clark, 2023; Verma et al. 2021; Hsu, 2023). Thus, the personalized feedback provided by AI-driven tools can help, especially novice researchers, improve their academic writing skills (Floridi & Chiriatti, 2020; Pinkwart, 2016; Thomas et al., 2023; Noy & Zhang, 2023; Giglio & Costa, 2023).

3.3. Contributing to exploration of academia and expanding access to knowledge

It should be noted that artificial intelligence technologies that have quickly invaded higher education and academia made great contributions to exploring the academic realm. Thanks to AI, researchers can think more creatively by generating new, unexplored research questions, exploring knowledge gaps in their disciplines, or even rephrasing traditional concepts with new perspectives based on predictive analysis, using tools like ChatGPT (OpenAI), Claude, or Jasper AI. These smart tools can be used to generate initial drafts, suggest titles, research questions, summaries, or even thematic classifications of ideas, besides highlighting potential areas for further exploration (Müller et al., 2022; Tauchert et al., 2020). For example, natural language processing algorithms do more than just scan academic literature; they break down complex scholarly work into discrete data points, reshaping the way researchers interact with existing knowledge (Tauchert et al., 2020). These capabilities make AI a virtual collaborative partner in the research process, not just a tool for performing routine tasks. Not only has artificial intelligence contributed to the exploration of academia, but it has also expanded access to knowledge. Smart research tools such as Semantic Scholar and Google Scholar which are AI-powered tools can suggest new sources based on the researcher's interests, automatically filter results by type, date, or topic, and provide knowledge maps that help understand the development of

concepts and relationships between studies. This represents a qualitative shift from traditional research to smart research, where researchers not only search for what they know, but they also discover what they did not know.

3.4. Supporting researchers with special needs

One of the important and humanitarian benefits of artificial intelligence is supporting researchers with disabilities by providing tools that convert text to speech and vice versa, enable voice interaction with AI systems, and assist in exploring documents and reading tables and data audibly. For example, students and researchers with communication disabilities, like cerebral palsy or dyslexia, ChatGPT can facilitate written communication for them (Heidt, 2024). AI-powered tools can also facilitate reading comprehension for neurodiverse researchers by summarizing, simplifying, and explaining content (Heidt, 2024). According to Marino et al. (2023), AI-powered tools, such as chatbots, can leverage data to deliver customized instruction, provide tailored feedback, and help reduce cognitive load for special needs students who may face challenges using traditional ways. This AI support for special needs researchers contributes to enhancing inclusivity in academic research and offers participation opportunities to researchers who previously faced real challenges in traditional academic environments. These assistive AI tools are extremely important for students and researchers with disabilities because they feel no different from their non-disabled peers when they have access to such AI tools (McNicholl et al., 2021). As Ciampa et al. (2023) noted, AI-driven tools can greatly support students with disabilities by enhancing accessibility and offering accommodations typically outlined in special needs education plans.

3.5. Facilitating cross-border scientific collaboration

One of the promising potentials of AI is the possibility to bring researchers together from different areas and specialties to collaborate and advance knowledge production. Some AI tools now enable researchers to share projects and analyze data collaboratively via the cloud by instantly translating academic content with high accuracy, and connecting with experts in similar fields based on research interests. For instance, Natural Language Processing (NLP) enables the automatic translation of academic papers between languages, effectively removing language barriers and fostering global collaboration. This accelerates the spread of knowledge and ensures that valuable research insights are easily accessible to a wider international research community, which contributes to strengthening international collaborative research and breaking down linguistic and cultural barriers among researchers. Therefore, AI serves as a powerful tool to enhance knowledge and foster connections, making collaboration among researchers more efficient and effective. Furthermore, the rapid progress of AI has led to the emergence of interdisciplinary fields like AI ethics (Mittelstadt, 2019; Hagendorff, 2020), which encourages, for instance,

deeper collaboration and dialogue between technology developers and researchers in the humanities and social sciences. On the whole, the importance of AI in research lies in its capacity to improve collaboration, overcome geographical barriers, and promote interdisciplinary partnerships that drive meaningful scientific progress. In fact, AI does not merely offer theoretical promises, but it actively contributes to reshaping the research process by accelerating it, improving its quality, increasing accuracy, and enabling a wide range of researchers to be more productive. However, these benefits come with limitations, which will be discussed in the next section, focusing on the perils and challenges associated with the use of these AI-powered tools.

4. The perils accompanying the use of AI-powered tools in academic research

Despite the numerous benefits of using AI tools in academic research, excessive or uncontrolled reliance on them can lead to a range of risks and challenges that affect academic research in terms of originality, credibility, and ethics. This section reviews the most prominent of these challenges and provides examples of how they can negatively impact the academic process.

4.1. Risk of scientific plagiarism and loss of originality

One of the major challenges of AI is the possibility of plagiarized work and loss of originality. Actually, the increasing use of AI writing tools in academia has raised concerns about plagiarism and violations of academic integrity, which is central to ethical scholarly practice (Bretag, 2018). Tools like ChatGPT may produce high-quality content, but without proper citation, their use can result in unintentional plagiarism. For example, novice researchers often turn to tools like QuillBot or Grammarly for paraphrasing, but this can blur the line between original and borrowed ideas, especially when sources are not properly acknowledged (Burkhard, 2023; Yusuf et al., 2024). Over-reliance on AI tools also risks diminishing researchers' critical thinking and writing skills. Generic AI-generated suggestions can undermine originality and personal expression. Scholars such as Ismail (2024) warn that excessive use may weaken essential research skills like editing, proofreading, and idea development. Similarly, Marzuki et al. (2023) note that students who depend heavily on AI often lose focus and produce lower-quality work. More broadly, the use of AI in academic writing can lead to issues such as improper citation, copying of ideas, and a lack of originality, all of which threaten academic integrity (Pudasaini et al., 2024; Cong-lem et al., 2024). Legal concerns are also emerging in the form of reflective questions such as "who owns AI-generated text? Is it the user or the developer? Can it be published without infringing on existing copyrights?". Since generative models are trained on existing texts, there is a risk of plagiarism or copyright violation. The solution lies in

using AI as a supportive tool, and at the same time the researcher reviews outputs critically and cites all sources appropriately.

4.2. Risk of bias in AI tools used in academic research

AI systems rely on training data, which may include cultural, gender, or racial biases, resulting in non-neutral outcomes. For example, a research model trained only on Western studies might neglect research from South studies. This can lead to reproducing academic biases instead of addressing them. In fact, many studies have shown that language models, which are typically trained on extensive web-based datasets, may encode biases related to gender, race, ethnicity, and disability status (Basta et al., 2019; Hutchinson et al., 2020; Tan & Celis, 2019; Zhao et al., 2019). This can unintentionally reinforce and spread underlying biases when these models are integrated into academic research, which threatens knowledge diversity, affects the inclusivity of academic research, and shakes the strong foundations of evidence-based knowledge. Furthermore, studies conducted by Singh et al. (2021), Kundi et al. (2022) and Akgun & Greenhow (2022) demonstrate three types of bias: biased input data, algorithmic bias and cognitive bias. When the data used to train AI models containing these biases, the credibility of research is challenged and inaccuracies of findings are very likely to occur.

4.3. Lack of transparency and difficulty in interpreting results

The lack of transparency in research work assisted by AI is another challenge in academic research. In this respect, some AI tools are like "black boxes," which make it challenging to understand how they produce specific results. This lack of transparency raises concerns about verifiability, as researchers are unable to examine each step of the analytical process. Such opacity can lead to blind reliance on outcomes that are not fully understood, and this undermines the ability to reproduce robust results, which is a cornerstone of scientific research. For instance, in quantitative studies, using a classification algorithm without clearly documenting its inner workings and decision criteria presents significant issues. In this respect, “[T]here should be an emphasis on improving the transparency and interpretability of AI-generated results. This includes documenting the methodology and parameters of AI tools and ensuring that research findings involving AI can be independently verified” (Ekundayo et al., 2024, p.10). A fundamental ethical principle in using AI tools in research is transparency in disclosing the use of AI in writing or analyzing research, as well as clarifying the type of tool used, its function, and the extent of its involvement in producing results or drafting texts. For example, when using ChatGPT to generate a draft of a research abstract, this should be clearly indicated in the methodology or acknowledgments section. Not disclosing the use of these tools may violate research ethics and affect the evaluation of the work by reviewing committees or academic journals.

4.4. Privacy and data protection issues

Another risk related to using AI-powered tools in academic research concerns privacy and data protection. Some smart tools use cloud computing technologies, which exposes research and participant data to risks such as security breaches, leakage of sensitive data, and the unauthorized use of researchers' data to train models. This raises significant concerns about data privacy and ownership since participants' data can be used in unethical ways (Liaw et al., 2020; Tozzi & Cinelli, 2021). Consequently, researchers must be cautious when selecting AI tools and ensure that these tools comply with data protection regulations commonly agreed upon by the international research community. One of the most important ethical considerations in research, especially in qualitative studies, is protecting participant privacy. Researchers must ensure that AI tools do not transmit sensitive data to external servers without explicit permission and that prior informed consent is obtained from participants before using intelligent systems to analyze their data. For instance, using cloud-based tools to process sensitive interview or survey data without encryption or adequate security measures is a clear violation of research ethics and data protection standards (Loos, 2019).

4.5. Difficulty regulating AI use within academic institutions

Regulating the use of AI-powered tools in academic research poses complex challenges, especially as these tools has become deeply integrated into the research process. AI can accelerate data analysis, generate hypotheses, and even draft portions of manuscripts, offering significant advantages in efficiency and scope. However, this raises ethical and methodological concerns regarding authorship, originality, and reproducibility. When researchers rely heavily on AI-generated insights or content without transparent documentation, it becomes difficult to assess the validity of the findings or the integrity of the research process as a whole (Dalalah & Dalalah, 2023). Additionally, the use of AI models with opaque algorithms can compromise the reproducibility of results, which is a cornerstone of scientific rigor. In this regard, what complicates the issue is the lack of clear institutional policies and guidelines that address the role of AI in research (Ghimire & Edwards, 2024). in fact, existing frameworks for academic integrity and research ethics were not designed to account for the complexities and challenges introduced by machine-generated outputs. This regulatory gap creates uncertainty about how much AI assistance is acceptable, how to properly credit AI contributions, and how to ensure compliance with ethical standards. Without consistent oversight or guidelines for accountability, there is a growing risk of misuse, unintentional plagiarism, or data manipulation going unnoticed. To responsibly harness the use of AI in research, academic institutions must urgently develop transparent and enforceable policies that evolve alongside AI technology (Sullivan et al., 2023; Luo, 2024). This section shows that despite their power, AI tools impose real challenges on the ethical and legal principles governing academic research. Therefore,

cautious, transparent, and regulated strategies must be adopted when using these tools, emphasizing that the researcher remains primarily responsible for the accuracy, originality, and integrity of the knowledge produced.

5. Case studies on the use of AI-driven tools in academic research

To understand the practical impact of AI tools on academic research, it is important to review real experiences in using these technologies. This section presents some case studies, illustrating how AI tools has been employed in different research contexts, highlighting successes, challenges, and lessons learned.

5.1. Case Study 1: Accelerating literature review using AI

Bernard et al. (2025) conducted a study in which they tried to evaluate whether the AI tool Elicit adds value to the systematic review process when compared to a traditional manual method (an umbrella review by Tannou et al. 2023), by focusing on three key factors: repeatability, accuracy, and reliability. The study revealed that Elicit is a promising AI assistant for systematic reviews that offers the potential to complement traditional methods by uncovering additional relevant articles and streamlining parts of the workflow. However, the tool currently shows limited repeatability, partial reliability, and operational constraints like database coverage, making it unsuitable as a standalone solution. Thus, human judgment and validation remain indispensable.

5.2. Case Study 2: Using AI to draft research papers

Ziyang Xu (2025) investigated how AI tools are used in academic writing by analyzing authors' declarations in journal articles. Specifically, the study explored which AI tools are used, why they are used, and how usage patterns vary across different writer backgrounds. The study reveals that AI tools, particularly ChatGPT, are now widely used in academic writing, with the primary motivations being to enhance readability and correct grammar rather than to generate original content. Importantly, usage patterns vary significantly based on linguistic background and team composition; for instance, non-native English-speaking researchers and international research teams tend to rely more heavily on AI tools. These findings highlight the growing role of AI as an inclusive support mechanism, helping to reduce language barriers in scholarly communication. However, the diversity of use also signals the need for clearer journal guidelines, transparency in AI disclosure, and ongoing dialogue about ethics and authorship in the age of AI-assisted academic writing.

5.3. Case Study 3: Qualitative data analysis using AI-supported tools

In a study, Cook et al. (2025) explored how AI, including large language models like ChatGPT-4, can assist qualitative data analysis (QDA). The study presents three key

scholarly components: empirical experiment, scoping review, and critical literature synthesis. This study shows that AI, including generative models like ChatGPT-4, holds valuable promises for enhancing qualitative research, boosting efficiency, and enabling scalable analysis. Yet, the technology is not mature enough for deep interpretive tasks without human validation. Hence, researchers must stay engaged, reflective, and ethically informed when integrating AI into QDA workflows.

5.4. Case Study 4: Plagiarism detection using iThenticate in scientific journals

Rahman et al. (2025) tried to evaluate and compare the performance of two plagiarism detection tools, namely iThenticate and Ouriginal, by analyzing their similarity index outputs across multiple manuscripts. In this study, both tools demonstrated comparable effectiveness in detecting overlapping content in manuscripts, as indicated by consistency in matches and strong correlations. However, iThenticate tended to indicate a higher average similarity index, which might suggest greater sensitivity to similarity or perhaps differences in source coverage or detection thresholds. These findings suggest that while either tool can be viable for plagiarism detection, results should be interpreted with an understanding of tool-specific behavior and context. Therefore, this study suggests that both iThenticate and Ouriginal provide generally aligned results for similarity detection, and they can be considered reliable tools in academic integrity workflows. The higher mean similarity values from iThenticate could reflect differences in detection algorithms or database coverage, which is an important consideration for institutions and researchers interpreting similarity reports. Hence, researchers should be aware that different tools may interpret and report similarity differently, making it essential to combine automated detection with human judgment when assessing academic integrity.

6. Recommendations and future prospects for the use of AI tools in academic research

With the rapid progress of AI technologies and their increasing integration into academic research, the need becomes clear for strategies and recommendations to ensure the optimal and responsible use of these tools. This article presents key recommendations for researchers and academic institutions, and explores future prospects in this vital field.

6.1. Recommendations for researchers

As artificial intelligence continues to evolve, its integration into academic research offers both transformative opportunities and complex challenges. However, their effective use requires careful consideration of their limitations and the necessity to comply with ethical standards. The following recommendations are intended to guide researchers in responsibly incorporating AI-powered tools into their research process, ensuring that the

use of these tools aligns with the core principles of academic rigor and integrity. Hence, it is highly recommended that

- Researchers should be aware when dealing with AI tools as research assistants; they have to consider them as complements for human research and analysis, and not as complete substitutes.
- Training is very essential for professional development. So, researchers can enroll in training courses to understand the capabilities and limitations of these AI-powered tools, and to learn how to use them effectively because AI literacy is extremely important to harness the use of AI in academia.
- Transparency and disclosure are crucial for researchers to abide by ethical principles and respect academic integrity. They have to clearly state any use of AI tools at all stages of the research process to ensure credibility.
- Researchers need to carefully review and scrutinize their academic work, and not fully rely on AI-generated results or texts because human judgment and oversight are very essential in academic research.
- Also, it is better to ensure that the use of these AI tools does not violate data privacy or the rights of research participants in order to account for research rigor and credibility.

6.1. Recommendations for academic institutions

As hubs of knowledge creation and dissemination, academic institutions play a critical role in developing policies for the ethical and effective use of AI in research. These recommendations aim to support academic institutions in developing clear policies, fostering responsible use, promoting digital literacy, and ensuring that AI integration aligns with the values of academic integrity, transparency, and inclusivity. Thus, it is recommended that

- Academic institutions (universities, colleges, …) should establish clear policies on the use of AI in research and academic writing.
- They also should provide infrastructure and AI-supported tools either free of charge or at affordable costs for all researchers to guarantee inclusivity and equity.
- Academic institutions need to create ethics committees to monitor and regulate the use of these AI tools and address violations.
- They have to integrate educational courses on AI and its ethical implications into academic curricula.
- It is very crucial to promote research into AI to better understand its impact on academic work and to develop more trustworthy and transparent tools

6.2. Future prospects

The future of academic research is poised to be profoundly shaped by advancements in artificial intelligence. As AI technologies continue to evolve, they hold the potential to revolutionize academia. However, realizing this potential will require continuous

investment in infrastructure, ethical guidance, and researcher training to ensure that AI is used responsibly and inclusively in pursuit of knowledge. Therefore, as a researcher, I envision that

- Researchers in AI and Informatics disciplines should develop more transparent AI tools that allow researchers in other disciplines such as the humanities or social sciences to understand how results are produced in terms of algorithm interpretability.
- Enhancement of integration between AI and collaborative research through shared platforms will enable real-time international cooperation.
- Emergence of ethical AI technologies will prioritize fairness, privacy, and minimize algorithmic bias.
- Expansion of AI use in higher education will help students develop strong research skills and awareness of how to appropriately use AI-powered tools.

The successful future of AI-supported academic research requires a joint effort from researchers and institutions to adopt responsible and balanced use of these technologies while fostering a transparent and ethical academic environment. Briefly, AI is not a threat; it is rather an opportunity to enhance academic innovative practices when used with awareness and professionalism.

7. Conclusion

In light of the rapid advancements in the field of artificial intelligence, it has become clear that AI tools represent a true revolution in academia. They offer tremendous potential to streamline research tasks such as data collection, analysis, and the generation of content. However, these tools are not without challenges and risks related to originality, ethics, privacy, and transparency. In this article, I explored various aspects of using these tools, from the promises they offer in accelerating research and enhancing researchers' skills to the risks that may threaten the integrity of the scientific inquiry. I also discussed the ethical considerations, alongside case studies illustrating diverse experiences with levearging AI tools in research. Therefore, responsible and balanced use of these tools, supported by clear institutional policies and ongoing training for researchers, is the optimal path to harness AI in academic research and achieve a more productive and transparent academic future.

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Originality in Academic Writing – Revisiting Critical Thinking in the Age of AI

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This topic investigates the way in which academic writing could benefit from AI tools. Academic writing can often be perceived by students as time-consuming, in both reading for producing a text and actual writing. Even though this might be true, it is still important not to neglect three levels of operating in (academic) writing and to make sure to always cover them precisely to build originality. The levels could be considered the following: (i) micro level – for grammatical structures and style; (ii) meso level – for structural coherence and organization; (iii) macro level – for goals, literature review, research question, etc., depending on the purpose of the text. For this presentation, I did not collect any empirical data from my students, as the proposal focuses on a theoretical framework. Thus, this paper proposes a series of AI-based tools (such as ChatGPT, Elicit, Grammarly) that can help students refine each of these levels.

Artificial intelligence; academic writing; immersive learning; originality; critical thinking.

1. Introduction

1.1. Aim

The present paper investigates the use of artificial intelligence (AI) in academic writing and the way in which it might affect originality and critical thinking. It is widely known that AI has become a tool that is frequently used by more and more people, especially students. If so, it is educators' duty to make students understand the importance of critical thinking in such times, making them differentiate between random information brought together and information that creates sense. Moreover, the originality issues should be addressed as plagiarism could be easily overlooked while using AI tools.

At the same time, through this topic, the aim would also be to build a replica of these theoretical frameworks that can be addressed to empirical data collection and analyses. They can be replicated in both in-class teaching and individual learning. The key

aspect of using these tools is to understand how to use them accordingly and how to retrieve information in order to train critical thinking and avoid plagiarism.

1.2. Methodology

The paper focuses on a theoretical approach and it does not collect any empirical data from my students. It focuses on presenting the main pedagogical uses of these AI-based tools, such as ChatGPT, Elicit or Grammarly. Even so, there are a few limitations that should be discussed, usually within the pedagogical framework and the ethical implications that might arise while using AI-based tools in teaching and learning: privacy policy of data, plagiarism or doctrinal impact.

1.3. Building the background

Using AI tools in education has become a trend that many educators and students prefer to adopt and adapt to their needs. However, an important aspect is that all the skills would originate from a general basis, for which the technical industry does not only apply computer science principles, but also linguistic, psychological, neurological, mathematical approaches. It is important to understand that when we write, we make use of a series of skills from various areas that help us build a context, understand the facts/ information behind it, conceptualize and exemplify with it etc., all of these contributing to our critical thinking.

When it comes to academic writing, it has been often stated, even before the age of AI, that it is a 'vehicle of generating new knowledge' (Ondrusek, 2012, p. 178), which is still a valid consideration of our times, but the question that might arise in the digital age refers to originality. While a considerable number of people are pursuing academic degrees and eventually careers, it is difficult to find original topics that have never been discussed before. Many students might have this perception that they always have to discuss or write about a totally new topic, however, it is important to reshape the understanding of 'originality' in the digital world. It is crucial to make students understand that there are many fields in which crafting a brand-new topic is very difficult and, sometimes, in academic contexts, we might just need some new corpora, new perspectives and approaches, new methodology etc. to an already existing topic. This should not affect their originality as long as they have a clear understanding of the topic, a clean style of writing, promoting ideas that belong to them, yet using modern tools that can refine some of the skills. Using these kinds of methods are always adaptive, because a recurrent question that adapts to each generation is 'to what extent are these activities really "new"?' (Colpaert, 2006, p. 477). What we have to understand is that, through the use of AI, the methods adapted to the actual needs and to the amount of work the modern world implies. It also implies a way of incorporating AI in our lives, making sure to simplify it (Alfredo et al., 2024), making us switch from studying about AI to studying with the help of AI (Son, Ružić & Philpott, 2023 *apud* Kukulska-Hulme et al., 2020). Many of these methods have been, perhaps, replicated from previous stages in which students had to use a combination

of computer-based and human-based communication in tasks such as the ones proposed by Bañados (2006), where students have to work in groups in order to solve a computer-based activity. This method can be easily replicated in an AI-based environment, where students can test their decision-making capabilities individually (non-assisted by an AI) vs. in group (+ AI-assisted).

Alongside originality, Ondrusek (2012, p. 179 *apud* Bynum & Ferguson, 1981; Casanave & Hubbard, 1992; Koncel & Carney, 1992; Jones et al., 1995; Caffarella & Bannett, 1997; Shawn, 1999; Rose & McClafferty, 2001; Linder, Murphy, Wingenbach & Kelsey, 2004; Lavell & Bushrow, 2007) summarised that a few other important skills and competences needed in academic writing would be (i) organization, (ii) argument, (iii) grammar, (iv) conceptualization, (v) accuracy and expression, (vi) sources, and (vii) critique, among others. Another key component is the 'common sense' and the way in which we build our arguments in accordance with the actual state of affair in the world, in accordance with history and other beliefs. Johnson, Insley, Motwani & Zbib (1993) considered that even though students are writing in a business-related environment or a technical one, the information still needs to be processed through the personal critical filter and question the validity of the information, i.e. it makes sense. This represents a switch from the so-called obsession on form (Hillocks, Jr., 2005) to considering the content and all the related issues (political, ideological, religious etc. concerns), making a shift from what Hutton & Gibson (2019, p. 94) call in one of their subchapters "You Have to Write Like That" to a more creative way in writing, a skill that should not be extremely rigid, making students more prone to such activities. Educators must make students aware of the importance of writing for developing related skills, not only to write for the sake of writing, and train their 'translation maturity' (O'Rourke, Connelly & Barnett, 2018, p. 17), in other words, to gradually invest in including real issues in their statements, not only to write to fulfill a task or complete an assignment. All these together could be separated into three categories through which we can operate when we talk about teaching academic writing, and those are (i) micro level (it incorporates grammar and style), (ii) meso level (it includes structural coherence and organization), and (iii) macro level (it refers to accuracy and expression i.e. the final 'look' of the text that reflects the type of writing we want to transmit).

2. Areas of improvement

Writing can be easily categorized as a time-consuming activity, be it an in-class or at-home assignment. It often includes more steps, the so-called pedagogical structures, of pre-writing, while-writing and post-writing, but they are not always included in each and every activity or while preparing for a competence exam. The focus in this paper is more towards pre-writing and while-writing activities, as the post-writing could be the subject of discussion in relation to speaking as well. If we are to consider the main concepts listed

above, they can be further summarised in these three core areas of improvement, namely: (i) micro level, (ii) meso level, and (iii) macro level.

2.1. Grammar and style

At the micro level, we can mostly consider the grammatical structures and style. As grammar plays a crucial role in writing, we have to make sure that students consider practicing it individually, for diverse topics, before having an actual draft of their essay. Even though essay writing usually implies a set of guidelines to be considered, they do not necessarily propose separate classes for grammatical discussion only. It is educators' duty to make sure students are constantly improving grammar in order to build trustworthy arguments, strong evidence, and clear style of writing. At the same time, the style of writing is also important as it mostly dictates the way in which the text can be interpreted by the readers. One common misconception is that using a formal counterpart of linking words, verbs or nouns is enough to have a formal piece of writing, but it is usually neglected the way in which we integrate those formal words within the overall syntactic structure of the paragraphs.

2.2. Paragraphs

Usually, the meso level implies structural coherence and organization. It refers to the way in which we build paragraphs, the flow of argumentation, the use of connectors, and the overall coherence of the text. This level is usually overlooked as we lack structural awareness. It is not enough to brainstorm ideas and put them in a draft, but students have to be aware of the fact that the meso level is the basic foundation of their essays in terms of argumentation.

2.3. Purpose

Lastly, the macro level refers to the sole purpose of the text as we see it as a whole. In this area, we must pay closer attention to the finest details that can make the difference between a research type of text and an argumentative one, for example. Students must understand the difference between different types of writing, based on the requirements they meet throughout different classes.

2.4. Overcoming the problem

As we might have identified a series of issues when it comes to academic writing, the point is to adress the root cause and overcome it. In the digital age, solutions can be diverse, starting with traditional methods such as task-based or project-based learning, but we can also adapt to the fast-paced learning style of our students and include AI-based learning methods in our classes. For that, some examples of applications or websites (not all of them AI-based) that might show results are included in the following list: ChatGPT

(preferably 4.0 and above), Elicit, Grammarly, Hemingway Editor, Linguix, DeepL Write, ProWritingAid, Writefull, Jasper AI, QuillBot, Wordtune, Connected Papers, Research Rabbit, Scholarcy, Scite, iThenticate. As this domain is constantly evolving, the list is open to more applications and websites (see Vera, 2023) that might be useful in the long run.

An important aspect in relation to using AI-based models is the prompting system. The idea of choosing the right prompts is not an emerging concept. It has its roots in teaching and learning in a traditional 'pen and paper' manner as well, where students were advised to build their own prompting system when summarizing or analysing a text in order to write a text of one's own: writing prompts before reading, while reading and post-reading (Pritchard, 1993). This idea has been adapted to the digital age as writing prompts to any LLM (Large Language Model) is crucial in making the difference between felicitous results or not.

3. Applying methods

Writing represents a complex process that implies reading (pre-writing activities), researching the issue, understanding it, mapping it in a comprehensible manner, and then putting it into words. For that, it implies different levels of operation, starting from the base of grammatical structures, spelling of the words, vocabulary choice, and formal style at the micro level of the text. Further, the paragraphs should follow a certain logical structure, making sure students train their reasoning abilities and understanding the flow of their argumentation. For this reason, we can talk about the meso level, where the focus is on structural coherence, text organization, but in a close relation to the micro level, where we integrate the connectors accordingly. Lastly, the macro level gives the final touch of the text, where we formulate its main purpose, the sections we want to integrate in the text. At the same time, it comes with a certain degree of originality building as we are trying to define the theme in such a way that has not been researched before or has not been debated before. At this level, it is worth noting that students usually get the 'text maturity' they need in order to convey research questions, to propose debate themes, and to bring evidence into discussion.

While applying these methods to either in-class or at-home assignments, educators should always prioritize the aspects related to originality and critical thinking. They can closely manage how students use any AI tool in order to complete a task by paying closer attention to the three levels of discussion mentioned above, the familiarity of the students towards the topics, and certain tasks usually performed before, while or after the writing process through research or critical inquiries on the essay or the text written by the students. Ideally, students can track these indices in the following manner: (i) before writing – if they use AI, to keep track of their prompting system and the suggestions they accepted or rejected; (ii) while writing – to adapt a concept to a new situation, showing their reasoning system or having an interdisciplinary approach; (iii) after writing – to have oral presentations based on their argumentation, also bringing new examples into account as

well as spontaneously argue on their topic. Even though, at first, there might be come communication anxiety regarding the post-writing tasks, however, they are relevant for maintaining a critical environment and an originality within their reasoning system.

3.1. Micro level

One of the main issues at the micro level has to do with the lack of grammatical knowledge or even practice. The most common mistakes I have observed during classes are the spelling ones, the use of tenses or the use of double subjects/ lack of pronominal subjects where needed. Even though the message is easily perceived by English speakers (native or non-native), for academic writing, there is indeed a need of refining grammatical mistakes. In order to make sure that the message we want to transmit is clear and there is no place for misinterpretation, educators should enhance the grammatical structures in such a way it does not become a standard text only but a flexible way of transmitting a message. For that, some tools suitable for this aspect can be found in Grammarly, Linguix or Writefull. Further on, some other tools might focus more on the style of writing, suggesting particular paraphrases and refinements as to have a formal text or at least neutral style, adapting it to the academic requirements mentioned. A list could consist of ProWritingAid and DeepL Write; however, this kind of task is also available in ChatGPT or any other LLM (for example, Grok, Claude, Perplexity, Jenni, LanguagePro or Gemini).

3.2. Meso level

At this point, the focus is on organizing the text in a coherent manner, working on the internal structure of the paragraphs but also extending to the overall flow. In this section, the general tendency is not to have one whole paragraph that incorporates all the main aspects of the essay/ text, but there is still needed to ensure a series of refinements (what to properly include in each paragraph, what connectors to use in accordance with the purpose of the paragraph, the argumentation flow etc.). For all of these, we can consider a series of applications such as Jasper AI, ChatGPT, QuillBot, Wordtune or Connected Papers. They mostly include restructuring information based on a prompt or a given text. This encourages the idea of originality on a topic that students have already chosen and it can be easily controlled by teachers/ professors by checking the amount of details included in the text. In general, the AI-based tools might have a tendency of overseeing some aspects or overgeneralizing them.

3.3. Macro level

The macro level usually comes as a final touch even though it is an aspect that should be considered from the beginning of the writing process. As it covers the main purpose of the text and it dictates the overall structure in accordance with its objective, the macro level can still make the difference between a research type of text, a descriptive one,

an argumentative one and so on. At this point, we can also tackle the plagiarism aspects, the bibliographical accuracy, and interdisciplinary issues. The main applications in this section are Elicit and Scholarcy (for summaries), Research Rabbit (for making interdisciplinary connections), Scite and iThenticate (for references and plagiarism).

4. Limitations

Working with AI comes with a series of limitations of different kinds, such as privacy policy of data, leading to plagiarism, creating false expectations or biasing responses based on the Natural Language Processing (NLP) counterpart of these applications or websites.

The digital age poses a series of challenges when it comes to privacy data. They are often exposed through iterative interactions, showing certain predilections of the user, things that might not be wanted by everyone using those interfaces. Moreover, the biased responses could also lead to a huge doctrinal impact, making it harder to obtain a neutral response while using the AI tool, especially when generating ideas. Of course, it is limited when it comes to refinements, but there are still cases when students might generate texts and use them for studying and learning.

More than that, the false expectations could be easily built while using LLMs as they might seem to be 'perfect' in the eye of the user, but they are constantly evolving, adding new capabilities and the analyses are always limited to the present time. In the future, most probably advanced features will be added to them and it will be impossible to set a limit.

Lastly, the limitations could also easily lead to plagiarism. Unfortunately, there are still many students who lack the necessary knowledge of avoiding plagiarism, the information that could pass as general knowledge and not marked as cited information or simply the proper way of marking the in-text citation or the references list. Luckily, once with the AI, more and more guidelines are available to the large public, but it is still educators' duty to closely monitor the writing process in schools and universities.

5. Conclusions

Summing everything up, it can be mentioned that the age of AI is bringing more and more challenges to the educational system, incorporating concepts such as originality in writing, the use of critical thinking while shaping an opinion or applying the ethical considerations of plagiarism as the AI interactions might make it difficult to distinguish between AI-written or non-AI written texts, an example being proposed by Dehouche (2021) with the use of GPT-3.

To do so, educators should not ban the use of AI in classes but to make students understand how LLMs work and how to responsibly use them while completing their tasks,

irrespective of the skill they want to enhance. As long as the students are capable of critically arguing their prompting system choice, their responses to the AI in the whole process of researching for the theme, and their own implication in the system, the interface between artificial and human intelligence is a safe place. As such, the suggestions we could address refer to three levels of actions, namely (i) the micro level for grammar and structure; (ii) the meso level for paragraphs; and (iii) the meso level for overall coherence.

6. Further inquiries

The further research section could include a series of proposals for the post-writing side of the process, especially for young learners or young adult learners. We can propose a series of follow-up tasks such as transforming the written text (depending on its type, but even the research texts can benefit from this type of transformation, especially for making it a more accessible way of studying the issue) into a story in pictures or any other visual representation with the help of AI, podcasts (they can be generated with the use of AI), games or songs. The proposal is not an emergent one as it has been discussed even since the 1985 by Balajthy as a conceptualization in accordance with the possibilities of the time (for example, Eliza). Another realisation could be through the use of art, proposed by Davidson & Jones (2024). However, further on, these ideas can be easily tested in a group project throughout the semester, helping students get familiar with the topic and AI usage as well.

On another light, an obvious follow-up activity would be to test the students' performance on online AI-based environment vs. a face-to-face non-AI-based environment adapting to Frantzen's methodology (2014) and updating to the current trends in AI. At the same time, it can be widely spread across students that we might not need to learn a new language in the digital age. For that, a further section can be based on Godwin-Jones' perspective (2019).

Lastly, another limitation would be in regard to the educational system. A proposal comes from Ministry of National Education [MONE] (2024) in Turkey and one of the findings refer to a perspective that some teachers might have in relation to it, namely a possible rigidity the educational system might acquires if constant AI exposure is considered. It is indeed an important aspect to be considered, for which we can consider a local replica of the above-mentioned study, applying the questionnaire to Romanian students and teacher alike.

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Übersetzung und künstliche Intelligenz. Welche Zukunft und welche Perspektiven hat das Sprachenlernen und die Sprachenübersetzung?/

Translation and Artificial Intelligence. What is the Future and Prospects of Language Learning and Language Translation?

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Artificial intelligence translation tools have facilitated global communication easier than ever before, thanks to the many applications in use today. The potential for easily closing language divides is certainly intriguing. Learning foreign languages is no longer the daunting prospect that it once was. With artificial intelligence, learners now have access to tailor-made online content in the chosen language, which closes gaps in knowledge and allows for self-directed learning. But in an outdoor classroom, it is hard to evaluate progress. Are they learning the proper word order and sentence structure? Do they struggle with pronunciation? Can AI help make these fundamentals more accessible? And perhaps most importantly: can students learn to get by without human teachers and translators altogether?

Language learning; translation; AI.

1. Einleitung

KI-Übersetzungen haben es einfacher denn je gemacht, für Menschen weltweit mit den vielen in diesem Bereich verfügbaren Anwendungen und Apps zu kommunizieren. Eine bezaubernde Idee, mühelos Sprachbarrieren zu überwinden. Eine neue Ära in der revolutionären Kommunikation ist bereits entstanden. Alles wird rasant übersetzt, beginnend mit Plakaten auf der Straße, Menu und Speisekarten in Cafés und Restaurants, bis hin zu Gesprächen, keine Sprachbarrieren mehr. Außerhalb einer traditionellen Lernumgebung ist es schwierig zu beurteilen, ob ein Lernender beim Sprachenlernen auf dem richtigen Weg ist. Ist er sich der richtigen Wortstellung und Satzstruktur sicher? Hat der Lernende Schwierigkeiten, die Aussprache zu beherrschen? Erleichtert ihm das Erlernen einer Sprache mit Hilfe von künstlicher Intelligenz, diese Grundlagen anzupassen? Kann er auf den menschlichen Lehrer und Übersetzer verzichten?

2. Überblick über die Entwicklungsphasen der KI

Das Aufkommen der künstlichen Intelligenz lässt sich auf die Zeit zwischen 1900 und 1950 als die eigentliche Periode des Auftretens des Begriffs beschränken, mit Theaterstücken und Filmen, die sich mit dem Thema Science-Fiction und Robotern in Form von künstlichen Menschen beschäftigten, die menschliche Arbeit verrichteten. Der erste Roboter tauchte 1929 von dem japanischen Biologen Makoto Nishimore in Japan auf (Bakkah, 2025).

Alan Turing entwickelte später den sogenannten Turing-Test, die Theorie von "Rechenmaschinen und Intelligenz" (Bakkah, 2025). 1956 fand dann die erste Konferenz statt, auf der über den Begriff und das Konzept der künstlichen Intelligenz an der Universität Dartmouth gesprochen wurde, und 1966 wurde der erste Roboter vorgestellt, der von künstlicher Intelligenz angetrieben wurde[1]. Forschungen und Erfindungen folgten danach, 1997 kündigte IBM einen Computer an, der den Schachmeister Kasparow[2] besiegen konnte. Wissenschaftler arbeiteten an der Entwicklung neuer Technologien, und die Forschung führte zur Entstehung von GPT, und künstliche Intelligenz wurde eingesetzt, um die Covid-19-Pandemie zu bekämpfen, den Fernunterricht zu verbessern und IA-Investitionen zu erhöhen.

3. Die Grenzen der generativen KI

In allen Bereichen, sowohl im Bereich der Übersetzung als auch des Sprachenlernens, hat sich die KI stark ausgebreitet. Künstliche Intelligenz oder maschinelle Intelligenz ist eine Menge von Methoden und Werkzeugen, die eine Maschine verwendet, aber auf

[1] https://tanqib4tech.com
[2] https://tanqib4tech.com

menschlicher Intelligenz basiert, mit Hilfe von bestimmten Programmen und Datenmengen planen, kreativ sein, neue Qualität reproduzieren, um Ziele zu erreichen und Lösungen mit hoher Genauigkeit zu finden.

Die generative künstliche Intelligenz konzentriert sich insbesondere darauf, neue Daten autonom oder halbautonom zu erzeugen. Zu den wichtigsten Anwendungen gehören: ChatGPT, Copilot, Gemini, Midjourney, Perplexity AI. Der kostenlose Zugang zu ChatGPT4 mag angesichts der Komplexität und der fortschrittlichen Fähigkeiten des Modells unerreichbar erscheinen. Es gibt jedoch mehrere Möglichkeiten, diese Technologie kostenlos zu nutzen, sodass Anwender ihre außergewöhnlichen Funktionen für verschiedene Anwendungen nutzen können (Malo, 2024).

KI ermöglicht eine Vielzahl von kostenlosen Anwendungen und benutzerfreundlichen Websites, die dazu beitragen, das Lernen durch vereinfachte Anwendungsprogramme zum Finden von Wörtern und Phrasen zu verbessern. KI verfügt über ein kontextuelles Verständnis, das so begrenzt ist, dass es schwierig ist, linguistische Semantik, idiomatische Phrasen oder alles, was kulturell ist, zu verstehen. Sie hat nicht die Fähigkeit, zu denken oder etwas Neues zu schaffen. Es fällt ihr auch schwer, mit sensiblen Informationen umzugehen, da es nicht zwischen ihnen und anderen Daten unterscheidet, sowie mit der Frage der Genauigkeit und Zuverlässigkeit, wenn es um kulturelle Werte oder einige obskure Texte geht, die eine genaue Erklärung und Interpretation erfordern, was zu katastrophalen Ergebnissen führen kann.

4. Künstliche Intelligenz und Sprachenlernen

Das Erlernen von Fremdsprachen ist kein großes Hindernis mehr und auch nicht mehr so schwierig wie früher. Wer früher eine Fremdsprache lernen wollte, musste viel Zeit und Geld in Gruppen- oder Einzelunterricht investieren. Während die traditionelle Bildung immer noch die beste Option für diejenigen ist, die lernen möchten, eine Fremdsprache fließend und korrekt zu sprechen, haben KI-Übersetzungsmaschinen einen langen Weg zurückgelegt, um das Erlernen von Fremdsprachen zu erleichtern. In Zukunft werden Mehrsprachige in der Lage sein, durch den Einsatz von künstlicher Intelligenz auf Online-Materialien in der Sprache zuzugreifen, die sie lernen möchten, um Wissenslücken zu schließen.

Es gibt mehrere einfach zu bedienende Anwendungen, die dem Lernenden helfen, Sprachen zu lernen und den Lernprozess zu verbessern, wo und wann immer er möchte, und sie bieten auch schnelle Lösungen und Übersetzungen. Diese Anwendungen ermöglichen es ihren Benutzern auch, über ihre virtuellen Bereiche mit künstlicher Intelligenz zu sprechen, zu chatten und Gespräche zu führen, aber sie werden nicht der Qualität einer traditionellen Lektion gerecht, die mehr Interaktion zwischen dem Lehrer und den Lernenden erreicht.

KI Überwindet Sprachbarrieren und erleichtert die Übersetzung von Dokumenten und die Kommunikation dank der 26 Sprachen, die das Sprachmodell beherrscht. Kein Wunder, dass Duolingo eine Premium-Version seiner App auf den Markt gebracht hat, die mit KI ausgestattet ist und Abonnenten mit einem personalisierten Tutor 2.0 unterstützt (Malo, 2024).

Künstliche Intelligenz kann jedoch die Bildung revolutionieren, indem sie innovative Lösungen zur Verbesserung der Qualität des Lernens und Lehrens bietet, und das haben wir während der Covid-Zeit gesehen, als jeder mit Herausforderungen und Schwierigkeiten konfrontiert war, die später angegangen wurden, um einen größeren Nutzen zu erzielen. Daher ist es möglich, vom Einsatz künstlicher Intelligenz in der Bildung zu profitieren, indem sie in die Gestaltung intelligenter Lehrpläne einbezogen wird, durch:

1. Integration von Technologie in Bildungsziele,
3. Analyse großen und komplexen Datenmengen, um Stärken und Schwächen zu identifizieren,
4. Identifizierung der Bildungsinhalte entsprechend den Bedürfnissen der Lernenden.

Ein Tool wie ChatGPT4 unterstützt Lehrkräfte unter anderem beim Unterricht, indem es ihnen Zugang zu einem reaktionsschnellen und anpassungsfähigen Tool bietet. Genau diese Verwendung schlägt pädagogische Innovation vor, um Lehrkräften zu erklären, wie sie das Sprachmodell von OpenAI in ihrem Alltag optimal nutzen können (Malo, 2024). Das Management von Bildungseinrichtungen stützt sich auf Algorithmen der künstlichen Intelligenz in:

1. Adaptiver Bildung durch Bereitstellung von Bildungserfahrungen für Lernende, Analyse ihrer individuellen Daten und Messung ihrer Lerngeschwindigkeit, Bereitstellung von Bildungsvorschlägen, die an die Bedürfnisse des Lernenden und sein Bildungsniveau angepasst sind.
2. Intelligenter Bewertung kontinuierlich und unter Verwendung von Tools der künstlichen Intelligenz und Identifizierung von Bereichen, und über die Techniken und Muster der Analyse schriftlicher Texte und Prüfungen, die verbessert und geändert werden müssen.
3. Unterstützung des Lehrenden, indem die KI die Lehrstrategien verbessert, Empfehlungen und Hausaufgabenhilfe über virtuelle Assistenten anbietet.

Diese Anwendungen bieten den Lernenden einen fruchtbaren und benutzerfreundlichen Boden zum Erwerb eines umfassenden Wortschatzes sowie geeigneter Ausdrücke. Allerdings ist es mitunter schwierig, den richtigen Lernweg einzuschätzen, insbesondere wenn es um die Beherrschung der Aussprache, die Wortstellung sowie den Aufbau und die Struktur von Sätzen geht. All dies lässt sich nur mit der Unterstützung eines menschlichen Lehrers erreicht, der die Leistung des Lernenden korrigiert, anleitet, verbessert und bewertet.

5. Die Zukunft der KI-Übersetzung und des Sprachenlernens

KI-Übersetzung wirkt sich besonders stark auf das Sprachenlernen aus, hier sind einige Aspekte, die diese Auswirkungen berühren:

1. Genauigkeit in der Anwendung: Dank fortschrittlicher Algorithmen und maschinellem Lernen ist die KI-Übersetzung genauer und natürlicher. Modelle wie GPT4 sind ständig auf riesige Datenmengen angewiesen, die es ihnen ermöglichen, Nuancen und Zusammenhänge besser zu verstehen und widerzuspiegeln.
2. Sprachenvielfalt: KI-Systeme werden zunehmend in der Lage sein, eine breite Palette von Sprachen zu unterstützen, einschließlich seltener und weniger verbreiteter Sprachen. Dies kann dazu beitragen, Sprachbarrieren auf der ganzen Welt weiter zu verringern.
3. Echtzeit-Übersetzungen: Durch die Integration von KI in Mobil-Geräte und Apps werden Echtzeit-Übersetzungen zunehmend verfügbar, was nicht nur im Alltag, sondern auch im Geschäfts- und Bildungsbereich von großem Nutzen sein wird.

6. Perspektive des Sprachenlernens

1. Ergänzen statt ersetzen: KI-Übersetzungen sind zwar leistungsfähiger geworden, ersetzen aber nicht das Sprachenlernen durch traditionellen Unterricht und menschlichen Lehrer. Der Erwerb von Sprachkenntnissen bietet kulturelle, kognitive und soziale Vorteile, die durch reine Übersetzung nicht erreicht werden können.
2. Interaktive Lernhilfen**:** KI kann durch KI-gestützte interaktive Lernplattformen als leistungsstarkes Werkzeug im Sprachunterricht dienen, z. B. durch die Erstellung maßgeschneiderter Lernpfade, die den individuellen Fortschritt und die Bedürfnisse der Lernenden berücksichtigen.
3. Immersive Erlebnisse: Durch Technologien wie Virtual Reality (VR) und Augmented Reality (AR) können KI-gestützte Anwendungen Sprachlernumgebungen schaffen, in denen Lernende jederzeit und überall interaktive und realistische Gespräche führen können.
4. Automatisiertes Feedback**:** KI-Programme können sofortiges und detailliertes Feedback zu Aussprache, Grammatik und Wortwahl geben, was den Lernprozess beschleunigen und vertiefen kann.

6.1 Herausforderungen und Überlegungen

Nach einem Blick darauf, was KI im Bereich des Übersetzens heute verspricht, geht es um die Funktionsweise von Text-KI und die Frage, ob und wie maschinelle

Übersetzungssysteme das originäre Übersetzerhandwerk beeinflussen und verändern könnten (Förster, 2023, S. 2).

1. Kulturelle Nuancen: Trotz technologischer Fortschritte bleibt die Herausforderung bestehen, kulturelle Nuancen und idiomatische Ausdrücke genau zu übersetzen, da menschliche Übersetzer und Lehrer in diesem Bereich unverzichtbar sind.
2. Datenschutz und Ethik: Der Einsatz von KI beim Übersetzen und Sprachenlernen wirft Fragen zum Datenschutz und zu ethischen Überlegungen auf. Es ist wichtig, dass der sichere Umgang mit Daten und die Wahrung der Privatsphäre der Nutzer gewährleistet sein muss.
3. Zugänglichkeit und Inklusion: Es muss unbedingt sichergestellt werden, dass die Vorteile des KI-gestützten Sprachenlernens weltweit verfügbar sind, insbesondere in benachteiligten und abgelegenen Gebieten.

Die Integration von KI in das Erlernen und Übersetzen von Sprachen ist in beiden Bereichen eine wissenschaftliche Revolution, da sie eine breite Palette von Möglichkeiten bietet, die von verbesserten Lernmethoden bis hin zu nahtlosen globalen Kommunikationserfahrungen reichen. Das menschliche Element bleibt jedoch unverzichtbar für die Vermittlung kultureller Tiefe und authentischer sprachlicher Kompetenz. KI-basierte Übersetzungsdienste bieten schnelle und zugängliche Übersetzungen, mit denen wichtige Fakten und Informationen überprüft werden können. Obwohl Muttersprachler in der Regel beauftragt werden müssen, die wichtigsten Informationen zu überprüfen, erleichtern Echtzeit-Übersetzungsdienste Unternehmen und Privatpersonen die Erledigung ihrer Arbeit sprunghaft.

6.2. Vorteile der KI-Übersetzung

Die Übersetzung von Texten mit Hilfe künstlicher Intelligenz hat viele Vorteile und Nutzen, wie z.B.:

1. Die Übersetzung großer Mengen von Wörtern in jede Sprache läuft sehr schnell und mit weniger Aufwand.
2. Jede Sprache kann übersetzt werden, auch seltene Sprachen, für die es schwierig ist, spezialisiert qualifizierte menschliche Übersetzer zu finden.
3. Die Übersetzung erfolgt zu geringeren Kosten und mit geringem Aufwand im Vergleich zu einem menschlichen Übersetzer.
4. Audio- und Videoclips werden ebenfalls in hoher Auflösung untertitelt.

6.3. Nachteile der KI-Übersetzung

Zusätzlich zu den Vorteilen, die die KI-Übersetzung bietet, gibt es natürlich auch eine Reihe von Nachteilen und Problemen, mit denen Benutzer dieser Übersetzungsmethode bei ihrer Arbeit konfrontiert werden, wie z.B.:

1. Die wörtliche Übersetzung führt manchmal zu einem Missverständnis des übersetzten Textes.

2. Einige präzise und komplexe Sätze sind manchmal schwer richtig zu übersetzen.
3. Dialekte, Idiome und Redewendungen fehlen manchmal schwer zu verstehen und ihren Kontext genau zu übersetzen.
4. Der Übersetzung fehlt das Element der Kreativität und der Spannung, insbesondere der Ausdruck von Gefühlen und Emotionen in literarischen und poetischen Texten.
5. Die Vertraulichkeit der übersetzten Texte wird nicht gewahrt und kann für andere Zwecke verwendet werden.

6.4. Herausforderungen bei der Suche nach der Qualität von KI-Übersetzungsdiensten

Anwendungen der künstlichen Intelligenz versuchen, eine hohe Übersetzungsqualität zu erreichen, indem sie die Tools der künstlichen Intelligenz optimal nutzen. Zu den wichtigsten Herausforderungen gehören die folgenden:

1. Hohe Qualität oder niedrige Kosten

Anwendungen der künstlichen Intelligenz zeichnen sich durch ihre geringen Kosten im Vergleich zum menschlichen Übersetzer aus, aber die menschliche Übersetzung verleiht dem übersetzten Text eine hohe Genauigkeit und Qualität in Bezug auf die Übertragung hochspezialisierter Begriffe, Bedeutungen und genauer Phrasen, insbesondere solcher, die bestimmte Gefühle vermitteln, wie es bei literarischen und poetischen Texten der Fall ist.

2. Verzerrung bei der Übersetzung

Die Betroffenen versorgen Anwendungen der künstlichen Intelligenz mit Informationen und Daten, die ihre persönlichen Überzeugungen und Meinungen in verschiedenen Bereichen widerspiegeln, mit dem Ziel, das menschliche Denken nachzuahmen – im Einklang mit den Interessen der hinter diesen Anwendungen stehenden Institutionen Dies kann dazu führen, dass die Übersetzungsergebnisse einseitig und parteiisch ausfallen.

3. Genauigkeit bei der Übertragung und Übersetzung

Wie bereits erwähnt, stützen sich KI-Übersetzungsanwendungen auf vorherige Daten, die als Rohinformationen gespeichert wurden, was oft dazu führt, die richtige Aussprache nicht erreicht wird, was sich negativ auf den gesamten Übersetzungskontext auswirkt, insbesondere bei sensiblen Themen wie der Übersetzung politischer oder kultureller Themen.

4. Datenschutz

Die Websites sammeln während der Übersetzung Informationen über die Benutzer der Anwendung, um sie später ohne ihr Wissen für andere Zwecke zu nutzen.

6.5. KI-Übersetzung ins und aus dem Arabischen

Dank der modernen Technologie, insbesondere der digitalen, ist die wissenschaftliche Kommunikation zwischen den Gesellschaften viel enger und interaktiver geworden als je zuvor. Viele Bücher aus verschiedenen Disziplinen wurden übersetzt und ihre Übersetzer haben unterschiedliche wissenschaftliche Ansätze gewählt, um einen übersetzten Text zu erstellen, der dem Originaltext gemäß entspricht und die wissenschaftliche Ehrlichkeit, sprachliche und kulturelle Gleichwertigkeit in sich trägt, die dazu beiträgt, die Verbindungen der Kommunikation und des Dialogs zwischen Sprachen und Kulturen herzustellen.

Die wissenschaftliche und literarische Übersetzung aus und ins Arabische hat sich entwickelt und an die Sprachen der Welt eröffnet und ihr eine hohe Position eingebracht. Sie ist die viertgrößte Sprache der Welt in Bezug auf die Verbreitung und seit 1974 offiziell von den Vereinten Nationen angenommen von sechs Sprachen (Ali, 2023).

Jeder Übersetzer steht aufgrund mancher Unterschiede vor der Herausforderung auf kulturelle Konnotationen und Nuancen die Unterschiede in Betracht zu nehmen. Und so entstehen bei der Übersetzung viele kulturelle Hindernisse, die das Verständnis von Texten maßgeblich beeinflussen, vor allem:

1. Historische Unterschiede

Historische Unterschiede zwischen Völkern, die eine bestimmte Kultur prägen und der Öffentlichkeit unbekannt sind, müssen in der Übersetzung berücksichtigt werden.

2. Religiöse Unterschiede

Die Menschen unterscheiden sich in ihren religiösen Überzeugungen, die ihre Kulturen beeinflussen und sie vielfältig und einzigartig machen. Es fällt dem Übersetzer schwer, dem Zielpublikum die verschiedenen religiösen Überzeugungen und ihre Auswirkungen zu erklären.

3. Gesellschaftliche Unterschiede

Die gesellschaftliche Struktur jeder Gesellschaft unterscheidet sich von jeder andere. Manchmal fällt es dem Übersetzer schwer gesellschaftliche Merkmale auszudrücken, Bedeutungen ohne Fehlinterpretationen zu vermitteln.

4. Bräuche und Traditionen

Lokale Bräuche können für Empfänger aus verschiedenen Kulturen fremd oder unverständlich sein. Dies erfordert vom Übersetzer, diese Elemente zu klären oder kulturelle Alternativen zu finden. Da einige Sprachen spezielle Begriffe enthalten, spiegeln Wörter und Ausdrücke, Sprichwörter und Redewendungen, bestimmte kulturelle Konzepte oder Traditionen wider, die es in anderen Sprachen nicht gibt.

5. Sprachunterschiede

Fehlende Sprachinterviews, in denen bestimmte kulturelle Konzepte zum Ausdruck gebracht werden, können zu Bedeutungsverlust führen. Dies erfordert vom Übersetzer andere Strategien anzuwenden.

6. Kulturelle Verallgemeinerungen und Kulturelle Vorurteile sollen nicht auf die Übersetzung auswirken, wie z.B. die Vielfalt innerhalb einer bestimmten Kultur, oder persönliche Vorurteile, die negativ auf die Übersetzung auswirken. Solche Hindernisse erfordern Sensibilität und ein tiefes Eintauchen in der Kultur des anderen, um sie besser zu verstehen. So kann man von einer hohen Qualität des Übersetzungstextes und einer besten Genauigkeit der Beschreibung der verschiedenen kulturellen Konnotationen sprechen, die im Text enthalten sind.

7. Sprachliche Strukturen

Die Struktur von Sätzen und die Grammatik können von kulturellen Gepflogenheiten beeinflusst werden, da die Ausdrucksweise von Ideen je nach Kontext variiert.

8. Kommunikationsstile

Interkulturelle Kommunikationsformen, wie z. B. die Verwendung von Körpersprache oder Tonfall, variieren von einer Kultur zu einer andere, müssen in Betracht gezogen werden. Die Sprache ist nicht nur ein Kommunikationsmittel, sondern auch ein Spiegel, der unterschiedliche Traditionen, Werte und Kulturen widerspiegelt.

> Als Google Translate im Jahr 2006 eingeführt wurde, konnte es gerade mal zwei Sprachen übersetzen. 2016 waren es über 103 Sprachen und es übersetzte über 100 Milliarden Wörter am Tag. Das System kann nicht nur übersetzen, sondern transkribiert in Echtzeit acht der meistverbreiteten Sprachen. Maschinen lernen und sie lernen schnell (Cullen, 2020).

Nun, mit der Weiterentwicklung der künstlichen Intelligenz, sind neue Dienste und Anwendungen für die maschinelle Übersetzung entstanden, um die zunehmenden und häufigen Lücken im täglichen, praktischen und pädagogischen Leben zu schließen, insbesondere bei Sprachlernern. KI-Übersetzungs-Apps haben sich gut bewährt und Sprachlernern geholfen, die von der App für maschinelles Lernen angebotenen Wörter und Sätze zu verstehen und zu übersetzen. Aber die Frage ist, ist es wirklich möglich, auf die Rolle des menschlichen Lehrers und Übersetzers zu verzichten und sich nur auf die Maschine zu verlassen? Laut Dr. Ahmed Ali ist die Besonderheit der arabischen Sprache, die in keiner anderen Sprache zu finden sind, wie z. B. die Vielfalt der Dialekte, unterschiedliche Schreibmethoden. Die Dialekte werden nicht nur unterschiedlich ausgesprochen, sondern haben auch keine einheitliche Schreibweise, was es erfordert die Entwicklung der KI-Tools, um diese Ungleichheiten zu verstehen und effizient anzugehen" (Ahmad Ali, Qatar Foundation).

ووفقًا للدكتور أحمد علي، "تتميز اللغة العربية بتحديات فريدة وشيّقة غير موجودة في اللغات الأخرى، مثل تنوع اللهجات وتعدد طرق الكتابة، فهي لا تُنطق بشكل مختلف فحسب، بل كذلك ليس لها طريقة موحدة في الكتابة من لهجة لأخرى، وهو ما يستدعي تطوير أدوات الذكاء الاصطناعي لفهم هذه التفاوتات ومعالجتها بكفاءة".

"Mit Hilfe der KI" fügt er weiter "können wir verschiedene arabische Dialekte erkennen und unterscheiden, … um gesprochene Texte in Geschriebenes umzuwandeln und auch zwischen Sprechern aus verschiedenen arabischen Ländern zu unterscheiden. Zum Beispiel kann die KI Unterschiede in der Aussprache und Morphologie zwischen syrischen, algerischen und ägyptischen Sprechern erkennen, was sie zu einem wertvollen Werkzeug macht, um zwischen verschiedenen arabischen Dialekten zu unterscheiden" (Ahmad Ali, Qatar Foundation).

ويضيف: "باستخدام الذكاء الاصطناعي، يمكننا التعرف على اللهجات العربية المختلفة والتمييز بينها، ويتم ذلك من خلال تعلم الذكاء الاصطناعي من الكلمات والبيئات المختلفة لتحويل النصوص المنطوقة إلى مكتوبة، وأيضًا للتمييز بين المتحدثين من مختلف البلدان العربية. فعلى سبيل المثال، يمكن للذكاء الاصطناعي التعرف على الفروق في النطق وطريقة التشكيل بين المتحدثين السوريين والجزائريين والمصريين، مما يجعله أداة قيمة للتمييز بين اللهجات العربية المختلفة".

Qatar Computing Research Institut arbeitet mit vielen Bildungseinrichtungen im Land zusammen, um ein Programm für die Arabisch-Nicht-Muttersprachlern zu entwickeln. Es wird auch den Kindern und Jugendlichen beigebracht, wie sie es verwenden, die Aussprache arabischer Wörter, Sätze grammatikalisch und morphologisch richtig und korrekt schreiben. Das Fanar-Projekt ist das Ergebnis einer strategischen Zusammenarbeit zwischen dem Ministerium für Kommunikation und Informationstechnologie (MCIT) und dem Qatar Computing Research Institute (QCRI) der Hamad Ben Khalifa University (HBKU), gilt als eines der wichtigsten und neuesten Modelle der künstlichen Intelligenz auf Arabisch, da es sich auf eine riesige Datenbasis stützt. Es enthält mehr als 400 Milliarden Wörter hochwertiger arabischer Texte und wird verwendet, um genaue Texte zu erstellen, die zur Verbesserung der Vertretung der arabischen Sprache im Bereich der künstlichen Intelligenz weltweit.

Dr. Mohammed Tabakh, Principal Scientist bei QCRI, sagte: "Im vergangenen Jahr gab es einen Technologieboom. Mit dem Aufkommen großer linguistischer Modelle, die aber zu einem großen Prozentsatz von bis zu 95% von englischen Texten abhängen, streben wir nach einem bedeutenden linguistischen Modell, das auf der arabischen Sprache und ihren verschiedenen Dialekten als Hauptsprache basiert" (Mohammed Tabakh, Qatar

Foundation). Dr. Muhammad Al-Tabbakh erklärt, dass einer der wichtigsten Faktoren, die die wichtigsten linguistischen Modelle beeinflussen, sind Daten. Betreffend die arabische Sprache sind die Daten im Internet im Vergleich zum Englischen sehr gering, höchstens 1 Prozent. So wirkt die arabische Sprache als Randsprache im Gegensatz zu anderen Sprachen. Das Fanar-Projekt bemüht sich, das Arabische als authentische Sprache der ersten Klasse sei, und arbeitet daran, eine große Menge von qualitativ hochwertigen arabischen Daten, die das kulturelle, islamische Erbe und die vorherrschenden Werte tragen. Dr. Al-Tabbakh weist auch darauf hin, dass Fanar-Projekt eins der Anwendungen der generativen künstlichen Intelligenz ist, ihm wurde eine große Menge von Daten beigebracht. Es ist in der Lage, nicht nur alte Daten wiederherzustellen, sondern auch neue Texte und Daten zu erstellen: "Es besteht kein Zweifel, dass Fanar-Projekt eine Rolle bei der Förderung von Innovationen im Bereich der arabischen Sprache und der künstlichen Intelligenz sowie in verschiedenen Bereichen wie Bildung, Kunst und Medien und sogar in der wissenschaftlichen Forschung spielt" (Mohammed Tabakh, Qatar Foundation).

كما يُشير الدكتور الطباخ قائلًا: "لا شك أن فنار سيكون له دورٌ في تعزيز الابتكار في مجال اللغة العربية والذكاء الاصطناعي، وفي مجالات متعددة تشمل التعليم والفنون ووسائل الإعلام وحتى الأبحاث العلمية."

7. Brüder Grimms Märchen „Der alte Sultan“ und Übersetzung: Analyse und Vergleich

Aus diesem Grund und angesichts des Vergleichs der Übersetzung eines Textes aus dem Deutschen, ein Märchen von Brüder Grimm „Der alte Sultan“, ins Arabische von Nabil Al Haffar, einmal durch Microsoft-Translator und anderes Mal durch Chat GPT und DeepL. Wir möchten damit wissen, inwieweit die Übersetzungen mit der Übersetzung von Nabil Al Haffar kompatibel sind. Hiermit sind paar Beispiele:

Abschnitt 1:

Der alte Sultan: *Es hatte **ein Bauer** einen **treuen** Hund, der Sultan hieß, der **war alt geworden** und hatte alle Zähne verloren, so daß er **nichts mehr fest packen konnte**. **Zu einer Zeit** stand der Bauer mit seiner Frau vor der Haustüre und sprach: "Den alten Sultan **schieß** ich morgen **tot**, der ist zu nichts mehr nütze."* (Grimmstories.com).

*الكلب العجوز سلطان: كان هناك **فلاح** عنده كلب **وفي مخلص** اسمه سلطان، لكنه **تقدم في العمر** وفقد جميع أسنانه فـلم **يعد قادرا على الإمساك بشيء. وذات يوم** كان الفلاح واقفًا مع زوجته أمام باب الدار يتحادثان، فقال لها:" غدا **سأطلق النار** على سلطان العجوز، فهو لم يعد يفيد في شيء" .* ترجمة نبيل الحفار. Arabische Übersetzung von Nabil Al Haffar 2016.

السلطان العجوز: كان لدى مزارع كلب **مخلص** اسمه سلطان، وقد **كبر في السن** وفقد جميع أسنانه، بحيث **لم يعد قادراً على الإمساك بأي شيء. ذات مرة**، وقف المزارع مع زوجته أمام باب المنزل وقال: "**سأقتل** السلطان العجوز غداً، فهو لم يعد مفيداً في شيء". DeepL Übersetzung

السلطان القديم: كان هناك **فلاح** لديه **مخلص** يدعى السلطان، **كبر في السن** وفقد كل أسنانه، حتى أنه **لم يعد قادرا على الإمساك بأي شيء بإحكام. ذات مرة** وقف الفلاح مع زوجته عند الباب، وقال: "**سأطلق النار** على السلطان العجوز غدا، لم يعد له أي فائدة". Microsoft Translator.

السلطان العجوز: كان لدى **أحد الفلاحين** كلب **وفي** يدعى سلطان، **وقد شاخ** هذا الكلب وفقد جميع أسنانه، **فلم يعد بمقدوره أن يمسك بشيء بقوة. وذات مرة** وقف الفلاح مع زوجته أمام باب المنزل وقال: "**سأقتل** سلطان العجوز غدا **بالبندقية**، فلم يعد ينفع في شيء". ChatGPT-Übersetzung.

Der Titel des Märchens „Der alte Sultan“ wurde mit einer Deutung auf den Hund bei Nabil Al Haffar übersetzt, die im Original-Text nicht vorhanden ist, nämlich „ *الكلب العجوز سلطان*“. Die Übersetzung von Microsoft Translator ist eine wörtliche Übersetzung, „ *السلطان القديم*“, was irreführend ist, denn man kann nicht sagen, dass es um den Hund Sultan geht, weil das Wort „Sultan“ im Arabischen „König“ oder „Lehnshoheit“ bedeutet; und das Adjektiv „alt“ nicht im sinne vom Alter, sondern als „altmodisch“ oder „alte Sache“ übersetzt worden ist. Während der ChatGPT und DeepL eine adäquate Übersetzung gefunden haben, und zwar „*السلطان العجوز*“, obwohl die Übersetzung keine Deutung auf den Hund hinweist, denn, wie gesagt, „Sultan“ kann auf eine Person deuten und nicht auf ein Tier.

In diesem Abschnitt ist die Übersetzung des Wortes „ein Bauer“ mit dem Wort „***فلاح***“ in der Übersetzung von Nabil Al Haffar und vom Microsoft Translator identisch, nur der ChatGPT hat „einer der Bauern ***أحد الفلاحين***“ ausgewählt, während DeepL das Wort „***مزارع***“ ausgewählt hat. Dies aber kann ein Ackerbauer, ein Bauer, ein Farmer, oder ein Landwirt sein.

Das Adjektiv „treu“ wurde sowohl in der Übersetzung von Nabil Al Haffar als auch vom ChatGPT durch dasselbe Wort „*وفي*“ übersetzt, aber der Microsoft Translator und DeepL haben ein anderes Wort ausgewählt, nämlich „*مخلص*“, das „aufrichtige“ bedeutet. Dieses Wortes bedeutet etwas mehr als „treu“, jemand, der nicht nur treu ist, sondern auch wahrhaftig ist. Aus diesem Grund hat der Übersetzer Nabil Al Haffar beide Wörter benutzt „*وفي مخلص*“ d.h. „treu und wahrhaftig“.

Der Ausdruck „***war alt geworden***“ wurde unterschiedlich übersetzt, aber alle dieselbe Bedeutung haben, einmal als „***تقدم في العمر***“, d.h. „ziemlich alt“ von Nabil Al Haffar, andersmal als „***كبر في السن***“, d.h. „älter geworden“ vom Microsoft Translator und DeepL, oder als „***شاخ***“, vom ChatGPT, das „sehr alt geworden ist“ oder „im Greisenalter sein“ bedeutet.

„***nichts mehr fest packen konnte***“ wurde vom Übersetzer Nabil Al Haffar folgend übersetzt „***لم يعد قادرا على الإمساك بشيء***“, von DeepL und Microsoft Translator durch „ ***لم يعد قادرا على الإمساك بأي شيء***“ aber mit einem zusätzlichen Wort vom Microsoft Translator,

nämlich „***بإحكام***“ d.h. „fest“ und vom ChatGPT „***بقوة***“, d.h. „mit Kraft“ oder „stark“, so kam seine Übersetzung folgenderweise „***فلم يعد بمقدوره أن يمسك بشيء بقوة***“. Alle Übersetzungen haben den Sinn wiedergegeben, obwohl die beiden vom ChatGPT und vom Microsoft Translator genau präziser sein wollten.

„***Zu einer Zeit***“ wurde als „***ذات مرة***“ d.h. „einmal“ sowohl von DeepL, als auch von Microsoft Translator und auch vom ChatGPT übersetzt, nur Nabil Al Haffar hat den Ausdruck „***وذات يوم***“ d.h. „und eines Tages“ ausgewählt.

„Den alten Sultan ***schieß*** *ich morgen* ***tot“,*** das Verb „totschießen“, d.h. „schießen aus einer Schusswaffe“, deswegen übersetzt Nabil Al Haffar und Microsoft Translator mit „Feuer schießen“ „***سأطلق النار***“. Während DeepL den Sinn nur durch das Verb „töten ***سأقتل***“ übersetzt hat, hat ChatGPT das Verb „töten mit einer Waffe oder einem Gewehr“ gewählt „***سأقتل*** *سلطان العجوز غدا* ***بالبندقية***“.

Abschnitt 2:

Der arme Hund, ***der nicht weit davon in der Sonne ausgestreckt lag****, hatte alles mit angehört und* ***war traurig****, daß morgen sein letzter Tag sein sollte. Er hatte* ***einen guten Freund****, das war der Wolf, zu dem schlich er abends hinaus in den Wald und klagte über das Schicksal, das ihm bevorstände.* (Grimmstories.com).

سمع الكلب المسكين كل ما قيل، فقد ***كان متمددا في الشمس الدافئة غير بعيد عنهما،*** *فحزن لأن غدًا سيكون آخر أيامه. كان لديه* ***صديق مقرب*** *هو الذئب، فتسلل إليه في الغابة مساء وشكا له مصيره المنتظر.* ترجمة نبيل الحفار.
Übersetzung von Nabil Al Haffar 2016

الكلب المسكين، ***الذي كان مستلقياً في الشمس على بعد مسافة قصيرة،*** *كان قد سمع كل شيء وشعر بالحزن لأن غداً سيكون آخر يوم في حياته. كان لديه* ***صديق حميم،*** *وهو الذئب، فذهب إليه في المساء إلى الغابة وشكا له من المصير الذي ينتظره.* DeepL Übersetzung

المسكين، الذي ***كان مستلقيا ممدودا في الشمس ليس بعيدا،*** *سمع كل شيء، وكان حزينا لأن الغد سيكون يومه الأخير. كان لديه* ***صديق جيد،*** *كان الذئب، الذي تسلل إليه إلى الغابة في المساء، وأعرب عن أسفه للمصير الذي كان أمامه.*
Microsoft Translator

كان الكلب المسكين ***مستلقيا تحت أشعة الشمس على مقربة من هناك،*** *وقد سمع كل شيء، فحزن لأن الغد سيكون يومه الأخير. وكان له* ***صديق صدوق،*** *وهو الذئب، فتسلل مساء في الغابة وشكا إليه المصير الذي ينتظره.* ChatGPT

Die Art und Weise wie der Hund in der Sonne lag, wurde unterschiedlich übersetzt. Das Adjektiv (Partizip Perfekt) „ausgestreckt“ im folgenden Beispiel ***„der nicht weit davon in der Sonne ausgestreckt lag“*** kam einmal bei Nabil Al Haffar „***متمددا***“ als Partizip I, andersmal im Sinne von „liegend“ wie bei DeepL und ChatGPT „***مستلقيا***“, oder kamen beide Adjektive im Sinne von „liegend ausgestreckt“, wie der Fall bei Microsoft Translator „***مستلقيا ممدودا***“. Zum Wort „Sonne“ ist eine zusätzliche Bedeutung hinzugefügt, nämlich

das Adjektiv „warm“ „*متمددا في الشمس الدافئة*“ bei Nabil Al Haffar, und „unter die Strahlen der Sonne“ „*مستلقيا تحت أشعة الشمس*“ bei ChatGPT, während bei Microsoft Translator keinen besonderen Hinweis gibt, außer „in der Sonne“ „*مستلقيا ممدودا في الشمس*“ mit einer doppelten Bezeichnung des Liegens.

„Nicht weit davon“ wurde auch wechselnd übersetzt, zweimal im Sinne von „nicht weit“ bei Nabil Al Haffar „*غير بعيد*“ und Microsoft Translator „*ليس بعيدا*“, aber ChatGPT bevorzugt „in der Nähe davon“ „*على مقربة من هناك*“, und DeepL findet eine adäquate Übersetzung, nämlich den Ausdruck „*على بعد مسافة قصيرة*“ d.h. „Nur wenige Schritte entfernt“.

Das Adjektiv „guten“ beim folgenden Beispiel „einen guten Freund“ lässt sich verschieden übersetzen. Der Übersetzer Nabil Al Haffar hat es als „enger Freund“ „*صديق مقرب*“ bezeichnet, Microsoft Translator hat die folgende Übersetzung gegeben „*صديق جيد*“ „guten Freund“, aber ChatGPT hat es durch „einen aufrichtigen Freund“ „*صديق صدوق*“ übersetzt. DeepL bevorzugt „*صديق حميم*“ im Sinne von „enger“ oder „intimer Freund“.

Man stellt fest, dass die Übersetzungen in den geführten Beispielen, sowohl vom DeepL als auch vom ChatGPT fast identisch sind, und den adäquaten Sinn näher darstellen als die Übersetzung von Microsoft Translator, obwohl die Übersetzung des Titels irreführend ist. Man kann sie als erste Hilfe empfehlen, falls man die arabische Übersetzung von Nabil All Haffar oder einem anderen bekannten Übersetzer nicht in der Hand hat. Trotzdem soll man vorsichtiger sein, denn ein Sprachlerner konnte den Kontext nicht wissen, insbesondere bei kulturspezifischen Elementen. Jede neu gelernte Sprache enthält ihre eigene Kultur, Tradition und Ideologien, die mit der eigenen des Sprachen Lerners meistens nicht identisch sind.

8. Kann man auf den menschlichen Übersetzer verzichten?

Künstliche Intelligenz hat sich in allen Bereichen gut geschlagen, insbesondere im Bereich der Übersetzung, aber sie wird den menschlichen Übersetzer nie endgültig ersetzen. Da sie trotz des Versuchs, die Qualität der maschinellen Übersetzung zu erhalten und die Zuverlässigkeit ihrer Ergebnisse zu verbessern, immer noch nicht in der Lage ist, die Herausforderungen zu bewältigen, die mit der Beibehaltung des Stils des ursprünglichen Textautors verbunden sind, unter Berücksichtigung des gleichen Kontexts im übersetzten Text und des Verständnisses Umgangssprachlicher Dialektphrasen.

Darüber hinaus spart es viel Zeit und Mühe bei der Übersetzung großer Dokumente, aber es gibt keinen Ersatz für das menschliche Element, das den übersetzten Text durch die kreativ vorgenommenen Änderungen menschlich macht. Dies bestätigt, dass die künstliche Intelligenz, egal wie fortschrittlich sie sei, unweigerlich mit der Funktion des menschlichen Übersetzers verbunden ist.

9. Schlussfolgerung

Die Integration von KI in die Übersetzung und das Sprachenlernen verspricht radikale Veränderungen in beiden Bereichen. Sie bietet eine breite Palette von Möglichkeiten, von verbesserten Lernmethoden bis hin zu nahtlosen globalen Kommunikationserfahrungen. Die menschliche Komponente bleibt jedoch unverzichtbar, um kulturelle Tiefe und authentische sprachliche Kompetenz zu vermitteln. Nichts kann die Feinheit der menschlichen Kommunikation ersetzen, denn anstatt des menschlichen Übersetzers abzuschaffen oder überflüssig zu machen, würde es vernünftig Mensch und Maschine zusammenarbeiten und gegenseitig behilflich zu sein.

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Book Reviews

Alina Gabriela Negoescu, *A Semantic and Pragmatic Analysis of Tourism Advertising: Tourist Leaflets from Sibiu, Romania and South Dakota* (Presa Universitară Clujeană, 2013)

Diana-Anneliese Sopon

This book explores linguistic aspects of tourism advertising through the lens of semantics and pragmatics, focusing on meaning, context, deixis, implicature, and metaphor. It analyzes how language constructs persuasive messages, emphasizing discourse features and multimodal elements. A comparative study of Romanian and American leaflets provides quantitative insights into cross-cultural communication strategies.

Pragmatics; semantics; conceptual metaphors; discourse analysis; tourism.

The volume, titled *A Semantic and Pragmatic Analysis of Tourism Advertising: Tourist Leaflets from Sibiu, Romania and South Dakota, USA*, authored by Alina Gabriela Negoescu, PhD, and published by Presa Universitară Clujeană, represents a theoretical model for analyzing advertising language. Despite being published a decade ago, the book remains an important landmark in linguistic analysis, covering areas such as pragmatics, semantics, contrastive linguistics, applied linguistics, and LSP (Language for Specific Purposes).

The relevance of the book can be explained in several ways. First, it grounds the reader in essential pragmatic concepts (such as meaning, context, reference, speech acts, implicature, presupposition, etc.), which are foundational tools for analyzing language use. In today's world, communication relies more than ever on contextual nuance, and pragmatic competence is vital in interpreting media, politics, marketing, and cross-cultural interactions. Second, tourism is a global economic force, and the book offers a multifaceted

view of how language constructs experiences and sells destinations through the interdisciplinary approach of tourism advertising, combining linguistics, marketing, tourism, and discourse analysis. Third, the application of the book to real-world media, exploring actual advertisements and analyzing how metaphors and narrative constructs work, is crucial for media literacy. Fourth, the book's cross-cultural comparison and empirical research are important, as the challenge of localization versus global branding remains central to tourism.

Starting with studies such as *How to Do Things with Words* (Austin, 1962), *Studies in the Way of Words* (Grice, 1989), *Semantics* (Leech, 1974), *Speech Act Theory* (Baicchi, 2009), *Pragmatic Presuppositions* (Caffi, 2006), *Discourse and Power* (van Dijk, 2008), *The Cambridge Encyclopedia of Language* (Crystal, 2010), *On the Philosophy of Language* (El-Daly, 2010), and *Implicature* (Kasher, 2009), the author outlines a theoretical perspective on the analysis of marketing language in the first chapter. This perspective includes not only linguistic aspects but also socio-cultural considerations. The second chapter delves into certain pragmatic aspects of the touristic message, such as Grice's principle of cooperation and his maxims, as well as the types of speech acts present in advertising language. Thus, the chapter provides original insights into pragmatics, applying each cognitive pragmatics principle strictly to the analysis of advertising language. In the third chapter, the author highlights numerous linguistic elements of discourse, creating an overview of how these elements contribute to the characterization of advertising language. It considers how advertising language in English and Romanian adheres to linguistic principles such as relevance theory, the principle of cooperation, deixis, and conversational implicature. It also explores the relationship between language expressing emotions, speech acts, and the cognitive pragmatic character of advertising language.

Another element of originality in this work is the identification of the conceptual and multimodal metaphors underlying the tourism advertising texts studied in the fourth chapter. Drawing on Lakoff's 1980 study *Metaphors We Live By* (Lakoff & Johnson, 1980), the author analyzes tourist brochures to identify and decode the conceptual metaphors in the slogans. The author demonstrates that conceptual metaphors offer a new perspective in tourism advertising by revealing the subtle ways in which systematized structures influence tourists' purchasing decisions. The final chapter synthesizes and confirms many of the qualitative results presented throughout the book. It also highlights the contrasting perspective of the study. It turns out that, although American leaflets provide less information, they suggest more, whereas Romanian leaflets take the opposite approach.

Thus, the importance of pragmatics within advertising discourse is clearly illustrated in this book, with the author providing examples where pragmatics plays a decisive role in the propagation of ideas and ideologies. In this way, concepts such as context, the theory of speech acts, and the principle of cooperation are applied to different instances of advertising discourse, with relevant examples. The author also precisely

identifies the role of semantics in advertising discourse, subjecting both conceptual metaphors and conceptual blending to analysis. Advertising language is portrayed as a metaphorical language, constructed to persuade. Deconstructing these metaphors allows for the analysis of their components, both linguistically and pragmatically. The case studies proposed by the book highlight how metaphors, metonymies, and analogies function within tourism advertising discourse. In conclusion, the book is not only useful for teaching purposes or applied contexts like communication in tourism and marketing, but it is also an important landmark for researchers in linguistics, communication (as related to pragmatics, semantics, contrastive linguistics, applied linguistics, and LSP). Its scope, from theory to practice, and from analysis to application, makes it a robust academic resource.

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