**Master Thesis Synopsis:** The use of AI as a tool to support teachers and students in creating and using educational content for higher education

**University:** Aalborg University (Copenhagen campus)

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**Summary**

The use of Artificial Intelligence (AI) in our day to day lives has been on the rise. AI is now present in our smart phones, websites, personal gadgets, etc. From undertaking complex tasks in the past to now carrying out even the simplest of exercises, we can see that AI is here to stay. One of the domains that has a promising future is the use of AI in education where it has potential to be applied as a solution to some of education's major issues present (Pedro et al., 2019). AI in education seems promising but it is salient to note that there are challenges that come with its use e.g., impact of AI on the teacher and student roles. There is also little evidence showing how the AI tools developed for education can be used together with educational theories to strengthen and deepen the synergy between the two (Chen et al., 2020). This research will be conducted in collaboration with Aalborg University (Copenhagen), Gulu University (Uganda) and the company CanopyLAB (Denmark). The scope of this thesis focuses on evaluating practical use of artificial intelligence in higher education by Gulu University teachers and students in creating and using educational content on the CanopyLAB platform via the AI powered features provided by the platform. This thesis report aims to investigate the use of an AIED tool developed in the global north (CanopyLAB - Denmark) but used in a global south context (Gulu University - Uganda). The limitation of this study is that it does not cover how CanopyLAB's artificial intelligence is developed or deployed for use and there will be no re-design of CanopyLAB platform based on the user feedback given. Also, there will be no direct collaboration with CanopyLAB the company but rather this will be a case study of CanopyLAB the platform. AI is no longer a field that seemed like it was only achievable in the distant future. I believe that there is significance in this project because of the recent increase in use of AI to solve problems and tasks that are both complex and easy. The methodology used in this research is a case study. The method implemented is use of online workshops as a method to collect data from the participants. From the literature review and analysis of the data collected from Gulu University participants, an artificial intelligence teaching tool is educational software or digital tool that can be used by teachers for teaching, identifying knowledge gaps, develop and publish courses, etc. A teaching tool can also be having a student or learner section whereby students can use. Based on this thesis research, gender and marginalizing of underprivileged communities are the main issues that cause inequalities and partialities because AIED developers may not be involving these communities when they indeed need to in order to produce sound results. In order to mitigate said issue, it is integral to involve the stakeholders of AIED as their opinions, feedback, concerns will be required. The main barrier or bottleneck based on this Gulu University research is minimal involvement of the global south in the development of artificial intelligence in education

# Contents

# INTRODUCTION

The use of Artificial Intelligence (AI) in our day to day lives has been on the rise. AI is now present in our smart phones, websites, personal gadgets, etc. From undertaking complex tasks in the past to now carrying out even the simplest of exercises, we can see that AI is here to stay. A superb example of how AI has advanced since it was introduced at the 1956 Dartmouth conference, is the "AlphaGo" program that defeated one of the top Go players in the world (Solomonoff, 1985; F.-Y. Wang et al., 2016). Artificial intelligence has become prevalent in domains such as education, engineering, medicine, security, retail, etc. with a global estimate of approximately two hundred and seventy billion US dollars by the year 2027 (Fortune Business Insights, 2020).

One of the domains that has a promising future is the use of AI in education where it has potential to be applied as a solution to some of education's major issues present (Pedro et al., 2019). The AI in education market has been estimated to be approximately 3.68 billion US dollars by the year 2023 (Markets and Markets, 2018). This increase could be as a result of AI-powered educational tools being used in learning institutions more and more over the past few years (Holmes et al., 2019). However, one should note that the domain of AI in education is still at its early stages of revolution even though there has been research on the topic for relatively thirty years and the research has not been fully implemented in schools (Bates et al., 2020; Zawacki-Richter et al., 2019). It is also not apparent how educators can leverage AI to give them more pedagogical opportunities and advantages while having a meaningful impact on teaching and learning (Zawacki-Richter et al., 2019).

One of the more evident pedagogical advantage or opportunity is the prediction of success or failure rate of a student using AI, compared to the evidence of how AI can influence teaching and learning in higher education – which is minimal (Bates et al., 2020). Some other ways in which AI can influence and affect education is through; a) improving information literacy and thinking ability, b) improving teaching quality and efficiency, c) promoting the development and construction of teaching resources and d) realizing efficient and personalized learning (Li & Wang, 2020).

AI in education seems promising but it is salient to note that there are challenges that come with its use e.g., impact of AI on the teacher and student roles, gender-equitable AI, data ethics and algorithmic biases while considering ethical, inclusive and equitable use (Miao et al., 2021). Lastly, there is the question of whether artificial intelligence will be a replacement for teachers or will it be used as a tool to empower both teachers and students (Bates et al., 2020)?

As promising as the capabilities of AI may seem or sound, it is important to also understand that AI does have its limitations. Some of these limitations include; high computational power and resources, possible overemphasis of success stories and debates about the genuine intelligence of AI (Miao et al., 2021). Human beings play an important role in the success of AI and it is beneficial if we are well prepared for this partnership (Holmes et al., 2019). There is also little evidence showing how the AI tools developed for education can be used together with educational theories to strengthen and deepen the synergy between the two (Chen et al., 2020). Artificial Intelligence in Education (AIED) has potential to bear great benefits but that depends on identifying and leveraging the benefits of AIED tools, while acknowledging and mitigating the risks, and possibly reviewing education's core fundamentals (Miao et al., 2021).

## Problem statement and research questions

In the introduction chapter, it has been stated that the research of AI in education has been going on for some time now while the application of AI is on the rise and it is being used in learning institutions more and more. However, based on Zawacki-Richter et al. literature review, there are a lot of promises in regards to AI's impact on learning and teaching but actually much is yet to be accomplished. This thesis looks at the various ways in which AI tools being used in higher education to support the teachers in teaching and what are some of the pedagogical or technical issues that come with the use of AI in higher education. These tools can be categorized into three distinct perspectives; learner facing, teacher facing and system-facing (Baker et al., 2019). Examples of the application of these tools in education by learning institutions include; profiling and prediction, assessment and evaluation, adaptive systems and personalization, intelligent tutoring systems,

dialogue-based tutoring systems, exploratory learning environments, automatic writing evaluation, and conversational agents (Dias & Bidarra, 2020; Zawacki-Richter et al., 2019). The problem statement for this thesis report is as follows;

> *"How is artificial intelligence being used in education to support students and teachers in their teaching, and what are the bottlenecks & barriers?"*

### Research questions

In order to answer the problem statement, the following research questions (RQs) have been formulated:

> **RQ1:** *What is an artificial intelligence teaching tool?*
>
> **RQ2:** *How are teachers and students using artificial intelligence as a tool to support their teaching and learning?*
>
> **RQ3:** *What kind of issues, inequalities & partialities arise from use of artificial intelligence as a teaching tool and how to create and use educational content powered by artificial intelligence that considers or mitigates these issues, inequalities and partialities?*
>
> **RQ4:** *How can we design artificial intelligence tools for education in a way that encourages its use by teachers and students?*

### Hypothesis

The following hypotheses have also been formulated in regards to this proposal:

> **H1:** The use of artificial intelligence as a tool in education by teachers is not as prevalent because of inadequate skills and preparation of educators by the respective institutions and certain government policies.
>
> **H2:** Teachers play a key role in contributing to the development of artificial intelligence for education.
>
> **H3:** The development and use of biased artificial intelligence in education will negatively affect the way in which people view this promising field.
>
> **H4:** Artificial intelligence is not a replacement for teachers, it is a tool to assist them with their teaching.

## Scope & Limitations

This research will be conducted in collaboration with Aalborg University (Copenhagen), Gulu University (Uganda) and the company CanopyLAB (Denmark). The scope of this thesis focuses on evaluating practical use of artificial intelligence in higher education by Gulu University teachers and students in creating and using educational content on the CanopyLAB platform via the AI powered features provided by the platform.

This thesis report aims to investigate the use of an AIED tool developed in the global north (CanopyLAB - Denmark) but used in a global south context (Gulu University - Uganda). Even though there is a shortage of seasoned AIED researchers in non-WEIRD countries, it is still important that scholars from WEIRD countries set a good blueprint for which non-WEIRD researchers can use on their respective cultures as this could be beneficial not only to their research questions but also in ideating new features (Blanchard, 2015). The limitation of this study is that it does not cover how CanopyLAB's artificial intelligence is developed or deployed for use and there will be no re-design of CanopyLAB platform based on the user feedback given. Also, there will be no direct collaboration with CanopyLAB the company but rather this will be a case study of CanopyLAB the platform. Hopefully, this could be something to look into as a future work recommendation for interested parties.

## Case description

CanopyLAB is an EdTech company that is based in Denmark and has branched out to the continents of South America, North America and Asia. Its domain of business is the education technology world, also known as EdTech, with a focus on remote and blended learning for educational institutions as well as companies. CanopyLAB combines Nordic learning principles, adaptive learning, a social network structure and artificial intelligence powered features. Some of the courses offered on the platform cover topics such as; technology, entrepreneurship, sustainability, democracy, etc.

There are two sides to the CanopyLAB system – the platform and the lab. The *platform* is the social network side of the CanopyLAB system whereby users have access to features such as newsfeed, direct messaging, learning spaces, following other learners, etc. which are very similar to features found on major social media platforms. Thus, the platform aims at giving the user a social learning experience as seen in figure 1 below.
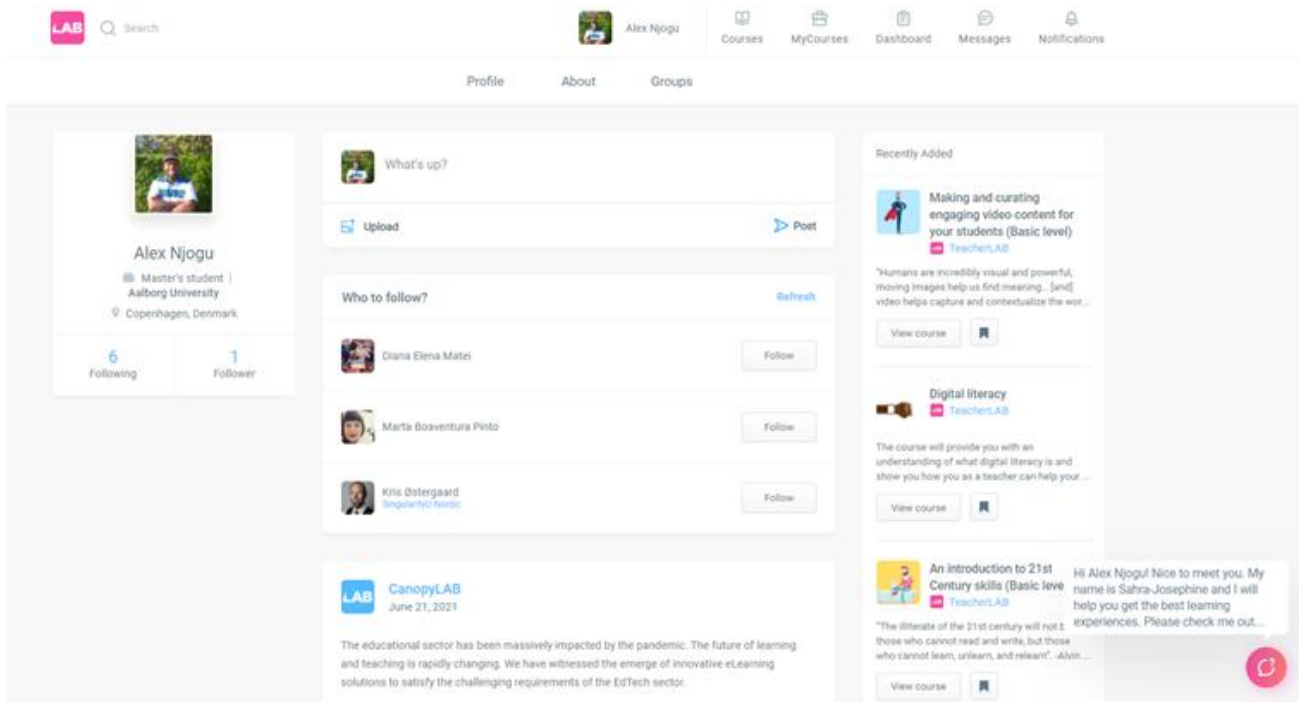
*Figure 1: A screenshot of the CanopyLAB platform*

The *lab* on the other hand is the side of CanopyLAB that users can take free courses and exercises. The users can also get insight about their course knowledge and skills either based on both the user dashboard and an individual's learning path. Like the platform side, the lab also lets users create a profile which can be customized to reflect a user's personality and competences. However, it is important to note that a user's account will require 'host privileges' to be granted to them in order to create a course on CanopyLAB. These privileges are granted by the administrator of the environment the user is in. It should be noted that hosts have extra settings available to them such as; adding and removing users, privacy and security settings, intuitive course builder, etc. Figure 2 below shows the features of the lab, indicator of who is a host, the courses enrolled and completed, messages from other users, grading status, notifications and generally how the lab looks like and what else it offers.
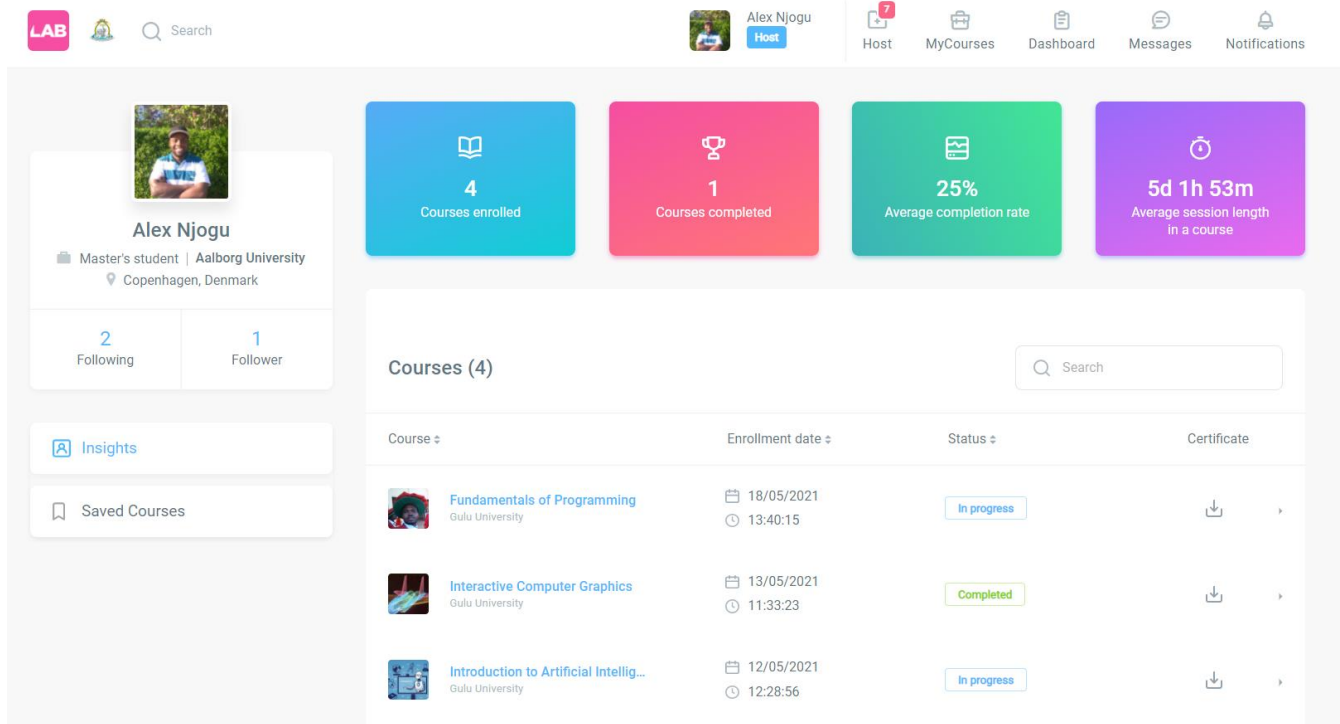
*Figure 2: A screenshot of CanopyLAB's host lab page*

Lastly, apart from the platform and the lab, CanopyLAB also incorporates a chatbot service and artificial intelligence into its product. There are four artificial intelligence powered features and they include; (i) exercise recommendations, (ii) autogenerated exercise content, (iii) meta tagging of all content and (iv) auto generated questions. These AI features are only present to the host when they are interacting with the course builder.

## BACKGROUND

The field of Artificial Intelligence (AI) was introduced at the 1956 Dartmouth conference (Solomonoff, 1985) even though it existed prior to that. After the Dartmouth conference, there were advancements in the field of A.I but maybe not as prevalent as present times. One of the main reasons for this was that funding for AI research was being castigated for the high amount spent on the field which resulted in termination of support from the British and United States government respectively (Haenlein & Kaplan, 2019).

Another reason was the limitation of what a computer could do back then and that most computers were only available at institutions or companies that had the resources to acquire one or more.

However, the 21st century generation of computers now have more capabilities e.g. computing power and data volume than the older generation of computers which were mainly used to execute commands as they could not store data. With this leap in technology, AI has also advanced as we see in the example of an intelligent computer Go program "AlphaGo" going against Lee Sedol who is one of the top Go players worldwide (Wang et al., 2016). Wang et al., tremendously highlight the fact AlphaGo won four matches out of five matches and this was considered a huge leap not only in AI but also in Information Technology as it had advanced to Intelligent Technology (2016, p. 113). This is just one of the many examples of AI application in our

daily lives and routines, especially in this digital era where data is available in large amounts and be collected and analyzed by AI systems e.g. to recommend movies based on what you have previously watched. AI is also being incorporated into other domains and fields such as medicine, engineering, agriculture, retail, surveillance, etc.

With the application of AI being on the rise in various domains, the domain of education seems to be one that is still in its early stages of this revolution despite being researched for about thirty years (Zawacki-Richter et al., 2019). This is because educators are now just starting to uncover ways in which they can incorporate AI into their pedagogical styles and methods in order to support learning (Zawacki-Richter et al., 2019). A systematic review carried out on use of AI in higher education resulted in four main ways that AI can be used in higher education; intelligent tutoring systems, adaptive systems & personalization, assessment & evaluation and profiling & prediction (Zawacki-Richter et al., 2019). From the research, there is evidence of four main AI application classifications and these four have even more subgroups within them. (Kochmar et al., 2022). In order to meet the requirements of a student profile, the resources that they learn from and teaching requirements need to be adaptive (Sharma & Harkishan, 2022). The use of AI in education and the manner in which it may influence educational policy is something that people may not be as aware of in comparisons to other sectors such as use of artificial intelligence in the military, healthcare (Schiff, 2021). Schiff points out that it would be helpful to consider social and historical application of technology in education in order to identify ways in which to steer artificial intelligence in education in general by investigating the effects of AIED (2021).

There is need for more research and application of AIED in order to have meaningful impact. In the context of global south, students from an Indian university were participants in research to provide a conversational agent to help them manage their stress levels. It is interesting to see that the agent was initially intended for the global north and this resulted in the finding that user context is integral to AIED in order to make it more culturally relevant. There is also a need for characterizing motivators and hinderances in order to motivate the relationship between the agent and user in a manner that considers the user's context and profile (Nelekar et al., 2022). A study conducted in Oman showed that there was a positive attitude towards AIED but said positivity is not generally reliant on their environment, gender and profession (Al-Badi et al., 2022). This could be advantage for the development of personalized AIED but there are other facets of personalized AIED that needs to be explored further e.g. the cost of implementing a personalized AIED system (Al-Badi et al., 2022). In order to have an effective ITS and higher levels of student satisfaction, there is a need for the educator to be able to properly analyze the learner's learning style in order for the developers to build an ITS that is adaptive to the students (Kumar et al., 2017).

This research conducts a literature review on which technologies facilitate personalized learning within a blended learning context. Things such as digital badges and competence based learning could be facilitate the actualization of personalized learning (Alamri et al., 2021). (evidence and solution – ways in which to facilitate AIED). (Chen et al., 2022). First world country governments' role in facilitating and supporting education technology plays a role in the increase of use and interest in AIED (Chen et al., 2022). It is important to note that Chen et al., research is not only constrained to higher education and thus some of their findings may be applicable in education in general or in specific contexts such as higher education. Some challenges that face AIED include; the conundrum of choosing between personalization and privacy and the educator's acceptance of AI (Chen et al., 2022).

The lack of theory and lack of critical assessment of educational and ethical considerations are two areas that seem to be very minimal in terms of literature. AIED can now be presented to schools in novel ways that not only consists of computers or touch pads such as use of sensors that are designed specifically for students and teachers rather than commercial or self-use (Timms, 2016). There is also an argument of the need for teachers in the future since schools will still be present and educational cobots will be required to help the educators (Timms, 2016). Timms also argues that data from these educational technologies can be used in various ways that could benefit educational stakeholders but it is important to also be cognizant of misuse of said data could end up being detrimental.

Zawacki-Richter et al. also point out that the potential of AI in education comes not only with benefits but also with risks such as; fear of AI replacing teachers and the use of private and confidential data from students and staff data to "feed" the AI (2019, p. 2). According to their analysis, the evaluation was evidence that satisfaction and motivation of students is key to encouraging them to use ITS tools even more and that digital educational tools may not work as intended leaving the users discontented, therefore inclusion of education stakeholders in assessing the technology is important (Yuce et al., 2019).

The need for chatbots in higher education can be used to offer support to students in the case where a teacher's input may be required but cannot be attended to at that moment. Chatbots can be used in education to make it affordable, accessible, available and in an inclusive environment. Some of the participants pointed out that chatbots could become cleverer in performing tasks that were presented to it by the users. Technical hinderances such as training time of the AI can restrict progress of AI in education (Gupta & Chen, 2022).

Trust plays a role in shaping the manner in which AI in education is looked at by its stakeholder's. From the analysis conducted on the netnography and interview data, the researchers found three main categories that influence user trust in AIED that are related to technology, context and individuality (Qin et al., 2020). The willingness of faculty to adopt AIED can be funneled down to 4 key points; advantage, compatibility, trust and faculty experience but each of the points are related to each other in how willing a faculty may be willing to adopt AIED e.g. the complexity is affected by experience and compatibility (S. Wang et al., 2020). Students with disabilities can benefit from use of artificial intelligence to create learning environments that have been developed with the said user in mind, in a way that is equal and on par with other students (Thapliyal et al., 2022).

Some challenges that come with the use of AIED include; impact of AI on the teacher and student roles, gender-equitable AI, data ethics and algorithmic biases while considering ethical, inclusive and equitable use (Miao et al., 2021). The use of web-based environments that are adaptive could make it difficult for in identifying the student's different styles thus disadvantaging the students (Lo et al., 2012). Designing an ITS requires contribution and collaboration from multiple disciplinaries such as pedagogy, computer science and artificial intelligence (Wei, 2022). There is also little evidence showing how the AI tools developed for education can be used together with educational theories to strengthen and deepen the synergy between the two (Chen et al., 2020). Lastly, there is the question of whether artificial intelligence will be a replacement for teachers or will it be used as a tool to empower both teachers and students (Bates et al., 2020)? This paper by Renz and Vladova argues for collaboration of humans and machine instead of setting the users aside. The adaptation of AIED could be hindered as a result of people are not being willing or open to adopt AI based on their perceptions (Renz & Vladova, 2021).

The literature review section of my thesis is integral to this part as it is used to support and debate the evidence of significant research in AIED. A 'narrative literature review' approach also known as 'semi-systematic review' (Snyder, 2019) has been adopted as a method to conduct the literature review. Currently, a total of 102 pieces of literature have been identified from ProQuest and Web of Science databases by using keywords that have been identified and will be presented as an appendix. The analysis of the literature has so far brought forth three main topics; AI in education, AIED tools and AIED ethics, partialities and inequalities. There are two more steps left in my literature review process and these are; completing the analysis, then structuring and writing the review (Snyder, 2019).

## Significance

UNESCO has identified that AI can not only be used to automate simple tasks but it can also be used innovatively to counter tough educational issues such as; lifelong learning companions, record of lifelong learning achievements and enabled continuous assessment (Miao et al., 2021). Considering that application of research about the use of AI by educators is not very widespread, it would be interesting to identify how AI can be implemented into education in order to foster equitable, accessible and fair education on a global scale (Zawacki-Richter et al., 2019). This research aims to contribute towards this by identifying what kind of AI tools do educators need, how educators interact with AI tools and what issues, whether cultural or ethical, arise from use of AI tools in an education context. By placing focus on the educators as a starting point to design or re-design AI, is integral in how the information conveyed to the AI by educators will be disseminated by their students. It is also important to have the teachers at the fore front of this technology in order for them to be more involved (Bates et al., 2020). AI is no longer a field that seemed like it was only achievable in the distant future. I believe that there is significance in this project because of the recent increase in use of AI to solve problems and tasks that are both complex and easy. The application of AI is becoming widespread and evident in our day-to-day routines and uses e.g. our smart phones, tablets, etc.

## RESEARCH DESIGN

This chapter entails the research design, data collection methods applied, participants, materials and tools, and procedure for the research. In the subsections of these chapter, there is more context provided as to how each of them is reasoned out and how it contributes to the overall project. This is a case study of the use of CanopyLAB platform by Gulu University teachers and students with the aim of offering a deep dive into how the participants interact with the platform. There are various types of case studies and the one that fits this research best is known as the *exemplifying case*, which means that it has been chosen because it represents a wider context (use of AI in higher education) thus providing context for answering the RQs (Bryman, 2016). Considering the research question formulated, there was a need to explore opinions, how teachers and students perceive the use of artificial intelligence in education. In order to do this, a qualitative approach was preferred and adopted whereby contextual inquiry workshop was the method used to collect the data. Quantitative was not employed in this case as there was no need to quantify the participants' feedback. However, it would still be possible to use quantitative methodologies in this case e.g. use of a survey to get user feedback on the application of artificial intelligence as an educational tool. Ethical considerations were also implied in accordance to The Danish Code of Conduct for Research Integrity (Ministry of Higher Education and Science, Denmark, 2014).

## Methodology & method

The methodology used in this research is a case study - as the intent of this research is to identify in detail the various concepts, thoughts and experiences based on traditions, opinions, values, culture, etc. that might be considered as not easy to quantify. The method implemented is use of online workshops as a method to collect data from the participants whereby workshop can be defined as "an agreement whereby a group of people learn, acquire knowledge, perform creative problem-solving or innovate in relation to domain-specific issue" (Ørngreen, & Levinsen, 2017). In this case the workshop is conducted online due to the geographical distance between the host and participants and partly due to the COVID-19 pandemic

## Procedure

The procedure incorporated three different online workshops that were used to guide the data collection from the participants. The three workshops are as follows; (i) introductory workshop, (ii), teacher's workshop (iii) student's workshop.

## Introductory online workshop

This was an introductory walkthrough of CanopyLAB for Gulu University teachers and students. The participants of this workshop required the following;

- Participants need to be added as members to the Gulu University learning environment via their email addresses by the administrator
- Participants should then receive an email asking them to 'claim their profile' by clicking on the link on the email from Gulu CanopyLAB environment
- Participants should receive confirmation email from Gulu University about successfully joining the environment after claiming their profile
- Participants should have access to CanopyLAB for this (could be in groups of two using one CanopyLAB account)

The schedule and activities formulated for the introductory workshop is as follows;

**Workshop 1:** Introductory workshop schedule and activities

**Time:** 9:30 am – 12:30 pm (EAT)

**Date:** 6th May 2021

**Venue:** The BSU container at Gulu University

*Phase one – Introduction*

At the beginning of the workshop, the facilitator and participants introduce themselves to each other as a way to familiarize themselves. This phase is to also ensure that participants present can access the Gulu environment on CanopyLAB. The tasks of phase one include;

- Facilitator introduces themselves, the workshop and the goals of the workshop
- Gulu participants introduce themselves
- A walkthrough of the Gulu - CanopyLAB platform

*Phase two – Activities/Tasks*

The following activities are to be carried out preferably in groups of two. Participants will be put into Zoom break out rooms to collaborate in the activities provided. The tasks include;

- Task one;
    - Create and enroll your profile
        1. Fill in your profile information e.g. profile picture, name, date of birth, etc.
        2. Click on *'my course'* option and enroll in the *'Preserving the climate in Uganda'*
- Task two;
    - Taking the course
        1. Read the *'course description'* in order to understand what the course is about
        2. Head over to *'Unit 1: Introduction'* on the left side of the course page and read the description provided
        3. Do the three exercises provided at the end of *'Unit 1'*
- Task three;
    - The dashboard
        1. Head over to the home page. Then Click on the 'dashboard' option & then 'learning path' option
        2. Based on the course you have tried out in task two, which 'knowledge' tags can you identify?
        3. Based on the course you have tried out in task two, which 'exercises' tags can you identify?

*Phase three: Conclusion of workshop*

This is the last phase whereby the workshop is concluded. This part will be for questions and reflections

- Participants and facilitator reflect on the task using the Padlet tool as sticky notes to post their feedback
    - In what way(s) do you think the CanopyLAB platform can be used for by Gulu teachers and students?
    - Are you familiar with any other education platforms that are similar to the CanopyLAB platform? If yes, which one(s)?
    - Based on today's walkthrough and tasks, what do you think about the CanopyLAB platform?

## Teacher's online workshop

This workshop was for Gulu University teachers which involves creating a course & exercises on CanopyLAB for Gulu University students. The participants of this workshop required the following;

- Consent to record participants in the workshop is compulsory
- Participants should have host access on CanopyLAB for this *(could be groups of two using one laptop)*

The schedule and tasks formulated for the teacher's workshop is as follows;

**Workshop 1:** Teacher's workshop schedule and activities

**Time:** 9:00 am – 1:00 pm (EAT)

**Date:** 13<sup>th</sup> May 2021

**Venue:** The BSU container at Gulu University

*Phase one – Propose a course*

At the beginning of the workshop, the facilitator and participants can re-introduce themselves to each other. The aim of this phase is to re-introduce the project idea & goals to the participants once again. Once that is done, the teachers are asked to brainstorm/discuss/propose some courses they would like to implement on CanopyLAB. Preferably a topic/subject that they have taught already or one that they are planning on teaching soon.  The main requirement is;

- o Participants should come up with a course that they can create on CanopyLAB, it could be a topic they have taught before or a topic they would like to teach in the near future. Preferably to be done in pairs to foster collaboration and discussion

*Phase two – Activities/Tasks*

The following activities are to be carried out preferably in groups of two. Participants will be put into Zoom break out rooms to collaborate in the activities provided. The tasks include;

Task 1 – *Unit 1 (please feel free to interact with the Chatbot service when creating a course, if you would like to do so)*

1. About section
    a. Fill in the *general information* page about the proposed course i.e. *title, introduction video, introduction and description*
    b. The *introduction video* can be a video you have recorded before or simply a YouTube video related to the proposed course
    c. Click the *continue* button once you are satisfied with your input of the about section
2. Settings section
    a. Set the *privacy* to *organization only* – this is to ensure that the students participating in the next workshop can log into CanopyLAB and take the course on the Gulu environment without the need for an invite
    b. Fill in the *other settings;*
        i. Status – set it to *on demand*
        ii. Participants – let it remain as *unlimited*
        iii. Start date – set the start date of the course as 17<sup>th</sup> May 2021 (Monday). This is because students will evaluate the course on that week, possibly 18<sup>th</sup> May 2021 (Tuesday).

    c. Click the *continue* button once you are satisfied with your input of the *settings* section

3. Units section

    a. Skip the *livestream* option for now

    b. Fill in the unit information i.e. *unit title, add speakers, video lectures, materials, unit description, knowledge tags, create an exercise* and an *image* that represents the unit

        i. *Add speakers* – this where you input the teacher(s) who will be in charge of that unit, this could be both of you or one of you

        ii. *Video lectures* – this could be one video or multiple videos related to the unit you are creating

        iii. *Materials* – this is where you can add files such as; papers, articles, link to articles, links to papers, etc....

        iv. *Unit description* - Based on your input in the video and material sections, CanopyLAB can generate a unit description for you. Of course, you can always write your own or tweak the suggested unit description to better suit your taste

            1. Try the *autogenerate unit description* option and evaluate the results the AI produces for you. Consider things such as; if that is how you would describe the course, what is missing, what works, what does not work, etc.

            2. If you are not content with the AI's *unit description*, you could either write your own *unit description* or combine the AI *unit description* and your own *unit description*

        v. *Knowledge tags* – the AI has analyzed your materials and suggests some *knowledge tags* for you. You can still add and remove tags manually.

            1. Evaluate the *knowledge tags* generated by the AI

            2. Choose if you would like to add or delete the *knowledge tags*

        vi. *Create an exercise* – the AI has analyzed your materials & suggests that you offer learners some exercises. You still have to fill out each exercise. You can still add and remove tags manually if you wish to. Once you are satisfied with the *exercise tags*, choose at least two *exercise tags* that you would like to create exercises for. Then move on to;

            1. *Exercise description* – you need to click the "pen" icon on the exercises tags you have chosen to work with in order to fill out the respective descriptions

                a. *Exercise status* – set the status to *require* in order for the students to do the exercise next week

                b. *Submission format* – this will depend on what your *exercise tag* aims to evaluate

                c. Skip the *automatic approval* option

    d. *Exercise description* – in some cases*,* the AI will generate an exercise description for you but other times you might have to create the exercise description using your own words. Feel free to use the suggested exercise text or simply formulate your own exercise.

    e. After step D, Click on the *close* button

   vii. *Images* – this is where you decide if you would like to add some images that are related to the unit you are creating

Task 2 – *Unit 2*

1. Repeat the steps in task 1 by creating a second unit related to the course you have created

*Phase three: Conclusion of workshop*

This is the last phase whereby the workshop is concluded. This part was set aside for questions and reflections

- Participants and facilitator reflect on the task using the Padlet tool as sticky notes to post their feedback based on a set of questions to be provided at phase 3.

## Student's online workshop

This workshop was for Gulu University students which involved creating a course (at least one course unit) & then taking exercises that were created by their teachers at workshop 2 on CanopyLAB. The participants of this workshop require the following;

  o Consent to record participants in the workshop is compulsory
  o Participants should have host access on CanopyLAB for this *(could be groups of two using one laptop)*

The schedule and activities formulated for the student's online workshop are as follows;


**Workshop 1:** Student's workshop schedule and activities

**Time:** 10:00 am – 1:00 pm (EAT)

**Date:** 20<sup>th</sup> May 2021

**Venue:** Online (Zoom meeting)

*Phase one – Propose a course*

At the beginning of the workshop, the facilitator and participants can re-introduce themselves to each other. The aim of this phase is to re-introduce the project idea & goals to the participants once again. Once that is done, the students are asked to brainstorm/discuss/propose some courses they would like to implement on CanopyLAB. Preferably a topic/subject that they have been taught already, something they are passionate about or a course that they are planning on taking soon. The main requirement for this phase is;

- Participants should come up with a course that they can create on CanopyLAB, it could be a topic they have been taught before, something they are passionate about or a topic they would like to teach in the near future. Preferably to be done in pairs to foster collaboration and discussion

*Phase two – Activities/Tasks*

After deciding which course(s) participants would like to create on CanopyLAB, the following activities are to be carried out preferably in groups of two. Participants will be put into Zoom break out rooms to collaborate in the activities provided. The tasks include;

Task 1 – *Unit 1 (please feel free to interact with the Chatbot service when creating a course, if you would like to do so)*

4. About section

    a. Fill in the *general information* page about the proposed course i.e. *title, introduction video, introduction and description*

    b. The *introduction video* can be a video you have recorded before or simply a YouTube video related to the proposed course

    c. Click the *continue* button once you are satisfied with your input of the about section

5. Settings section

    a. Set the *privacy* to *organization only* – this is to ensure that the students participating in the next workshop can log into CanopyLAB and take the course on the Gulu environment without the need for an invite

    b. Fill in the *other settings;*

        i. Status – set it to *on demand*

        ii. Participants – let it remain as *unlimited*

        iii. Start date – set the start date of the course as 20$^{th}$ May 2021. This way you are guaranteed that you can take/evaluate the course as soon as you publish it.

    c. Click the *continue* button once you are satisfied with your input of the *settings* section

6. Units section

    a. Skip the *livestream* option for now

    b. Fill in the unit information i.e. *unit title, add speakers, video lectures, materials, unit description, knowledge tags, create an exercise* and an *image* that represents the unit

        i. *Add speakers* – this where you input the teacher(s) who will be in charge of that unit, this could be both of you or one of you

        ii. *Video lectures* – this could be one video or multiple videos related to the unit you are creating

iii. *Materials* – this is where you can add files such as; papers, articles, link to articles or even links to papers, etc. *(try adding material that is in a native language e.g. Swahili, Luganda, etc. & see what kind of results you get)*

iv. *Unit description* - Based on your input in the video and material sections, CanopyLAB can generate a unit description for you. Of course, you can always write your own or tweak the suggested unit description to better suit your taste

    1. Try the *autogenerate unit description* option and evaluate the results the AI produces for you. Consider things such as; if that is how you would describe the course, what is missing, what works, what does not work, etc.

    2. If you are not content with the AI's *unit description*, you could either write your own *unit description* or combine the AI *unit description* and your own *unit description*

v. *Knowledge tags* – the AI has analyzed your materials and suggests some *knowledge tags* for you. You can still add and remove tags manually.

    1. Evaluate the *knowledge tags* generated by the AI

    2. Choose if you would like to add or delete the *knowledge tags*

vi. *Create an exercise* – the AI has analyzed your materials & suggests that you offer learners some exercises. You still have to fill out each exercise. You can still add and remove tags manually if you wish to. Once you are satisfied with the *exercise tags*, choose at least two *exercise tags* that you would like to create exercises for. Then move on to;

    1. *Exercise description* – you need to click the "pen" icon on the exercises tags you have chosen to work with in order to fill out the respective descriptions

        a. *Exercise status* – set the status to *require* in order for the students to do the exercise next week

        b. *Submission format* – this will depend on what your *exercise tag* aims to evaluate

        c. Skip the *automatic approval* option

        d. *Exercise description* – in some cases*,* the AI will generate an exercise description for you but other times you might have to create the exercise description using your own words. Feel free to use the suggested exercise text or simply formulate your own exercise.

        e. After step D, Click on the *close* button

vii. *Images* – this is where you decide if you would like to add some images that are related to the unit you are creating

Task 2 – *Taking a course created by Gulu teachers*

In workshop 2, the Gulu teachers/lecturers created several courses. Two of the courses have been published and the participants get to choose which one they would like to take. The courses are; (1) Fundamentals of Programming and (2) Interactive Computer Graphics.

1. Choose which course your group would like to take and then;
2. Head over to the *course page* for the course you have chosen. Look into the introduction, read the description & objectives of the course, take a look at the knowledge and exercise tags as well as the images. Once you are content, click on the *take course* button on the left side of your screen and agree to the terms of service that pop up.
3. Once you are enrolled, you can either click on the *continue* button on the bottom right side of your screen or you could click on *unit 1* on the top left side of your screen. Both will lead you to the *unit 1* page.
4. In *unit 1*, go through the *introduction*, *video lectures* and *materials*. Due to time factor and possibly internet connectivity, you might want to skip over the large sized materials e.g. books. But please feel free to look at the large sized materials if you wish to do so.
5. Upon completion of step 4, proceed to the exercises section at the end of the page. Whereby you are required to complete some exercise(s) so as to complete the unit.
6. Once you are done with the exercise(s) and discussion, click on the *continue* button on the bottom right of the page in order to proceed to the next unit.
7. Once you are in *unit 2*, please repeat step 4 & 5 from task 2.
8. When you are done with the exercise(s) and content with your answers, click on the *finish* course button on the left side of the screen.
9. Try and see if you can find the course tags (*knowledge tags* & *exercise tags*) that you have attained as a result of completing the exercise(s).

*Phase three: Conclusion of workshop*

This is the last phase whereby the workshop is about to conclude. But before that, a discussion and reflection is conducted together with the participants.

- Participants and facilitator reflect on the workshop using the Padlet tool as sticky notes to post their feedback based on a set of questions provided as they do the activities and after they complete all the activities.
- Thanksgiving for participation and collaboration, then conclusion from facilitators.

In phase three of the student's workshop; the participants were asked to interact with the CanopyLAB chatbot. Some of the tasks included interacting with the "Lise" chatbot by asking it to create a course on CanopyLAB and have it walk them through the process. Once the students were done with their respective tasks in relation to the chatbot -their feedback was requested in order to hear their perspectives on use of AI chatbot in higher education and their opinion on ethics and bias in AIED. Their feedback is expounded on in the analysis and findings chapter.

## Participants

The population involved with this research was Gulu University teachers and students from the Computer Science department and Business department. The recruitment of the participants was done in collaboration

with the liaison at Gulu University thus why Computer Science had the most participants. A group of five teachers and four students were involved in this thesis research. In the group of five teachers, four of them were from the Computer Science department and one of them was from the Business department. The four students were all from the Computer Science class. Two of the students were female and the other two were male. The table below illustrates the demographics of the participants group from Gulu University.

| Participant | Gender | Faculty (class) | Country of Residence |
|---|---|---|---|
| Teacher 1 (T1) | Male | Computer Science | Uganda |
| Teacher 2  (T2) | Female | Business Studies | Uganda |
| Teacher 3  (T3) | Male | Computer Science | Uganda |
| Teacher 4  (T4) | Male | Computer Science | Uganda |
| Teacher 5  (T5) | Female | Computer Science | Uganda |
| Student 1  (S1) | Male | Computer Science | Uganda |
| Student 2  (S2) | Female | Computer Science | Uganda |
| Student 3  (S3) | Male | Computer Science | Uganda |
| Student 4  (S4) | Female | Computer Science | Uganda |

Table 1: Participant information

As for the sampling, a purposive sampling approach was adopted because the research question is specific to a higher education context thus not likely to use convenience or random sampling as it may not have significant value at the time to the research question since not everyone is a teacher or a student (Taherdoost, 2016). Computer literacy and proficiency was not initially considered as there was an assumption that the participants would have some technical knowledge, familiarity or expertise.

## Variables and measures

From the problem statement, research questions and hypotheses formulated in section one of this document, the following dependent and independent variables have been identified.

*Dependent variable*

In the case of this research, the Gulu University participants interacting with the CanopyLAB AI and the context in which they interact with the AI are the dependent variables. This is measured by identifying what results arise from the participants interacting with the AI.

*Independent variable*

As for the independent variable, this ranges from age difference, gender of participant, ICT skills and their personality. These are things that vary from person to person and come into play when conducting the workshops tasks and also in the interviews.

## Setting & tools

Due to the participants and researcher being in different countries in the world, the logical option was to use online workshops to be conducted via the internet e.g. Zoom. The Gulu participants attended the workshops online from Gulu University, while I conducted the workshop online from Denmark. There will be three facilitators to moderate the workshops – one in Denmark and two in Uganda. The two facilitators in Uganda are teachers of Gulu University thus their experience and expertise with their fellow participants could be useful for the whole process.

The application called Zoom (version: 5.11.4) was used for video conferencing with the participants in Gulu University and was also used to record the entire workshop from the facilitator's side in Denmark. All participants had their personal laptops with them but were advised to use one as a pair to encourage discussions as they performed the workshop tasks. The facilitator in Gulu also recorded the sessions using a hand-held cam coder and a voice recorder placed at various points during the workshops. CanopyLAB's website was used by the participants to complete their workshop tasks by interacting with an AI powered tool – all participants had to be approved as hosts in the platform in order to be able to create a course of their choice. The online software, Padlet, was also used for online real time collaborative discussion and feedback between the participants and facilitators due to poor internet connection affecting the Zoom call quality. Students were also provided with five thousand Ugandan shillings in order to buy data bundles for their laptops during the third workshop as they did not have access to the school WIFI due to COVID-19, hence they had to work from home. In the first and second workshop, there was no COVID-19 yet and both students and teachers could use the university's WIFI.

## Population and Sampling

The population involved with this research was Gulu University teachers and students from the Computer Science department. An approximate of five teachers and four students will be involved in this thesis research. Out of the four students, two of them were women and the other two were men. There were three male teachers and two female teachers present. All the students and four teachers were from the Computer Science faculty while only one teacher was from the business faculty. As for the sampling, a purposive sampling approach (Taherdoost, 2016) was adopted because the research question is specific to a higher education context thus not likely to use convenience or random sampling as it may not have any value to this research since not everyone is a teacher or a student.

## Ethics

This research was guided and carried out in accordance to the Danish Code of Conduct for Research Integrity (Ministry of Higher Education and Science, Denmark, 2014). Since this research relies on the input from people, it is recommended and advised that they be treated respectfully and ethically based on the three principles from Danish code of conduct (Ministry of Higher Education and Science, Denmark, 2014) and three more from the Belmont report (Sims, 2010); Honesty, Transparency, Accountability, Respect for persons, Beneficence and Justice.

Written consent was requested after informing the participants what exactly was going to take place in each workshop and before any recording of the workshop sessions started. All participants were okay with being recorded as is evident in their written consents. Participants volunteered to participate and they were not coerced into doing the workshops. The data was collected in two parts; by the facilitators present in person

and online by myself. The facilitators sent me the data via a private Google Drive folder and once I had downloaded it, I deleted the data from Google Drive. Once I had all the workshop data with me, I put it up in a private OneDrive folder accessible only by one person. The data will be deleted once my thesis examination is completed in early 2022 – participants were informed that the data will be deleted after thesis examination.

## ANALYSIS

As mentioned at the start of the research design chapter, a qualitative method was applied in order to collect data from the teachers and students using CanopyLAB. The choice of analysis method used was the six step thematic analysis due to its flexibility and a strong analysis of the participants opinions and feedback and a theoretical approach is adopted because the research question does not evolve when going through the data (Braun & Clarke, 2006). Advantage of using TA is that it is a more usable method of analysis especially for students and researchers who are starting out, while also having a gentle learning curve for researchers who may have experience with other qualitative or quantitative methods (Braun & Clarke, 2006).

Braun and Clarke outline six phases how to go about thematic analysis and that is used as a guide for the analysis of the data collected for this thesis (2006). This include;

*Phase one – getting to know the data*

Once the data collection was done, the data had to be transcribed in order to go through it and have an initial idea on what the participants have given back as feedback. By doing this, it ensured that the data was familiar and that patterns were visible in the data collected. The data collected was partially transcribed due to poor internet connection while conducting the workshop, which affected the quality of the recording. However, there was a feedback session for all the three workshops whereby the participants used Padlet as a tool to write and describe their feedback and suggestions to questions they were asked by the facilitator. It was also transcribed "in a way which is 'true' to its original nature" (Braun & Clarke, 2006, p. 88) by relistening to the audio clips as thoroughly as possible despite the audio quality.

*Phase two – generation of primary codes*

Once the data was transcribed, it was copied into a Word document whereby it was placed into three columns; *(i) the question asked by the facilitator, (ii) the answer from the participants, (iii) the initial codes that are created from the answer of the participants*. The coding was done manually and was performed over the partially transcribed data, in a manner that reflected the research question at hand. At the start of the coding process, there were no predetermined codes and therefore the codes were formulated as the coding process advanced, which is defined as "open coding" (Maguire & Delahunt, 2017, p. 3355).

Some of the codes that in the initial stage covered a range of things. For example, the need for learning to be centered around the student. This is feedback from the teachers participating in the hybrid workshop which could be as a result of the teacher's knowledge and experience of what students require. To them, it is crucial that the use of artificial intelligence in education can be used to center learning around the student in a quick manner.  Another interesting piece of code that emerged was the presence of knowledge gaps in the students. Teachers find it useful if the artificial intelligence tool could be used as a way for them to determine or analyze if there is a disconnect between the knowledge they are offering and what the students are learning. This is

essential to the research question as it is related to how artificial intelligence can be used to support teachers and students in education.

Feedback from the students also provided some interesting initial codes such as; self-evaluation of students after completing an exercise. Whereby the students expressed that it is advantageous for them if artificial intelligence could assist them in performing a self-evaluation after they have performed an exercise, maybe as a result of how quick the artificial intelligence tool gave them feedback based on the exercises they did in the workshop – but that will need to be investigated further. Students also expressed that they were not content with how the artificial intelligence chatbot they were using as it did not perform as they thought it would. That is an interesting thing to note as it means the students might have a preconceived idea of how chatbots work or that the chatbot is very rudimental and has a limited set of questions and answers for them. So, how educational chatbots operate in an educational setting is important to the student as it is there to assist them. Making sure it functions as expected by the users is crucial to whether they will adopt it as a tool to assist them in their learning process.

*Phase three – searching for themes*

Braun & Clarke's definition of a theme is "a theme captures something important about the data in relation to the research question, and represents some level of *patterned* response or meaning within the data set" (2006, p. 82). They also point out that there are no set rules for searching for themes and rather a theme is identified by its significance to the research. The stage of coming up with codes and identifying possible themes may overlap at times, considerably (Maguire & Delahunt, 2017).

With this definition in mind, and with the codes in place, the next step was to identify patterns or themes that emerged before finalizing the generation of codes and themes that appeared after codes were formulated. This was done by grouping codes into themes that looked relevant to the research question. The themes identified were prescriptive – in that they were a description of the coded data identified in phase two (Maguire & Delahunt, 2017). All the themes identified are in the analysis table whereby the codes are collated together to a certain theme and at times some codes may be associated with more than one theme. A good example of this is the code from students' and teachers' responses "uncertainty in response/feedback" from the educational appears in the theme of "user satisfaction" and "effectiveness of AIED." An example of code that is related to one theme is "inclusion of local language" which is related to the theme of "local dialect/culture." It is important to note that not all themes may be fit for the research question and it is alright to pick and choose the strong relationships between codes, sub-themes and themes that are related to the research question (Braun & Clarke, 2006). An initial thematic map was used to identify which codes belonged to which themes and if there were codes and sub-themes that would have to be set aside due to a weak relation, or no relation at all, to the research question at hand. This is to make sure that the data is analyzed exhaustively as possible because the process takes time and review of the initial codes and themes might be necessary in the next phase.

*Phase 4 – reviewing of themes*

After identifying themes in phase three, one has to refine the present themes in order to identify which themes are not strong enough to stand alone. This could be as a result of lack of enough data to make a relation or present data might be too broad. In order to do this, the collated extracts for the themes were read again in

order to see if there was coherency between them and their respective themes. The themes that did not match with their extracts had to be reevaluated on whether they could fit into other extracts or if completely new themes had to be generated. Microsoft Word was used to place the extracts, their respective codes and themes together in order to read them and see if they made sense or not. Then, look at the themes to see if the context in which they have been placed, also works across the entire data set.

An example of an initial theme that did not fit, or rather seemed to stand alone – in regards to the data set, was "Artificial intelligence teaching tool." The theme is very broad and might encompass all the other themes identified and therefore it does not really give the reader an understanding of how it is related to the research question. Some codes e.g. "use of AI in practical settings" was a stand-alone code from the data extract that initially did not have a coherent connection to a theme. Upon looking into it further, in the process of phase 4, it appeared to fit into the theme of "user satisfaction."  There was also emergence of more than one sub-theme within the themes, an example of this are the sub-themes "student-centered learning" and "learner-centered education" which both fall under the "learning experience"  theme. This was interesting to the research question because learning experience is something that both students and teachers put emphasis when they were giving feedback at the workshop.

*Phase 5 – define themes*

Once a defined set of themes that highlight aspects of the data and what they entail is identified, researchers present them explaining what is interesting about them and why that is (Braun & Clarke, 2006). In the case of Gulu University participants, the themes need to be defined in order to write a comprehensive analysis of the data collected.  Braun & Clarke recommend that when at phase five of the thematic analysis, it is helpful to give the themes names that give an immediate sense of what the theme could be about. First off, the themes identified had to be in connection with the research question(s). Once they were identified they were then arranged in a way that relates to the data (Nowell et al., 2017). The themes provided at this time are not the final ones as there is an option of modifying and refining them even more, preferably by other researchers who are familiar with the research question(s) or data at hand (King, 2004). Below is the initial thematic map that indicates the initial themes and their corresponding sub-themes.
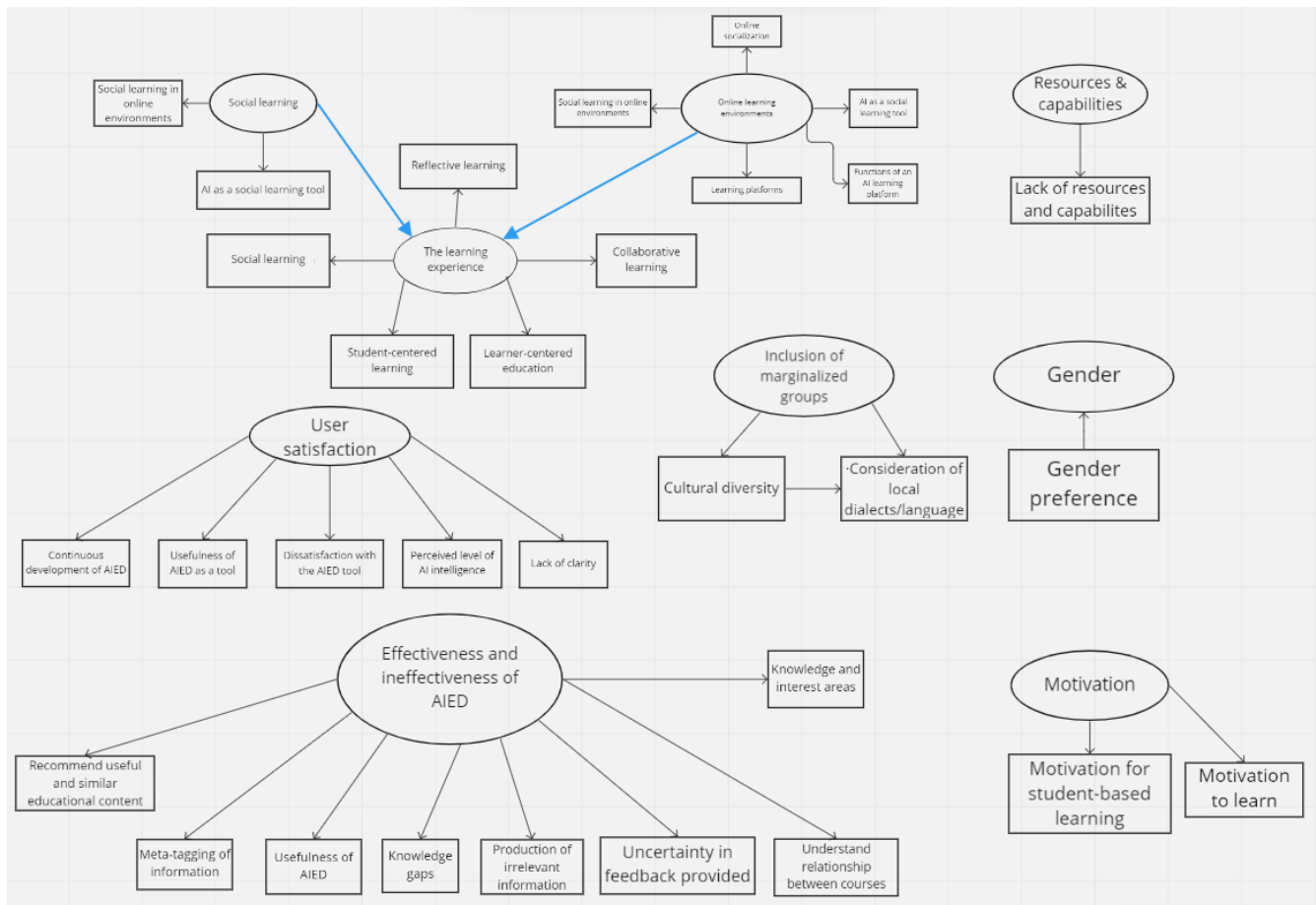
*Figure 3: The initial thematic map*

*Phase 6 – produce report*

Once the themes have been defined and the analyst is content with the results, the final step is to write and explain the themes in order to explain in a clear manner for validity and merit reasons (Braun & Clarke, 2006). Therefore, themes should be explained in a manner that is also evident and adequate in the data extract and that it makes sense to the reader. The report produced should not only be a definition of the themes but also indicate how the analytical results are related to the research question. The themes and sub-themes identified from the data analysis and their presentation is presented as findings in the next chapter.

## FINDINGS

### Theme one: The learning experience

The theme of *learning experience* has five sub-themes within it; *social learning, reflective learning, collaborative learning, learner-centered learning, student-centered learning.* This indicates that learning is a vast experience that is multi-faceted and is dealt as such within this report. Learning experience in this case is related to the use of technology (artificial intelligence) in a hybrid environment (physical meeting place and

online courses) to facilitate learning for students as intended by their lecturers (teachers). There is a mix of what may be considered as traditional setting – students getting information from their educators – or in a modern setting which students can learn by interacting with educational technology. *Social learning* can be simply put as "learning from others" (Lind et al., 2019, p.2). This means that, ideally, students can learn from interacting with each other socially. The information can be passed from a one-to-one basis or across a group of students. In the case of Gulu University, the teachers who participated in the workshop expressed that social learning is beneficial with one teacher saying;

> *"The social learning experience is great for students and teachers." – T2*

This statement can be translated as the teacher's opinion on whether CanopyLAB platform can be used by students and teachers of Gulu University. This could be as a result of teacher's previous experience with the phenomenon of social learning and they might view AI as a tool to encompass this.

*Reflective learning* is a process in which one learns through recounting their everyday experience(s). This is evident in the feedback provided by one of the students when asked on what they think about the exercise tags that they had earned upon completion of their workshop tasks. Student 3 says;

> *"They are all good for student's self-evaluation after the course" -S3*

Student 3 views the exercise tags as a way to recount or be retrospective with what they have learnt from the exercise that they had completed. This may be important for them because the exercise tags are in short form and highlighted on each completed exercise and this could be considered as appealing to the student.

*Collaborative learning* occurs when a group of people, in this case students, work together to find a common solution to a problem that might have been presented to them by their teacher(s). Therefore, students have to interact, engage and communicate with each other as a way to learn and this is indicated by teacher 4 when asked what they think about CanopyLAB platform and says;

> *"it's a collaborative environment which enhance learning." – T4*

The statement above indicates that the teacher views CanopyLAB as a learning platform onto which students can work in pairs or groups to achieve a common learning goal. Another perspective of the statement above is that traditionally, group work is done by having physical meetings to plan and execute respective learning goals but it does not always have to be that way as it can now be done online in regard to CanopyLAB platform. This indicates that online collaborative learning could be successful in enhancing learning for Gulu teachers and students.

*Learner-centered learning* can also be termed as *student-centered learning* whereby students engage with each other in discussions about a specific topic whether physically or online. Students are at will to choose what it is that they would like to learn and how they will learn it, making them take on an active role rather than a passive one. Student-centered learning could also be referred to as how schools customize their teaching process to accommodate the different types of students that may be present at that institution. In the case of Gulu University, when asked about what way(s) do teachers think the CanopyLAB platform can be used by Gulu teachers and students, teacher 3 replied by saying;

> *"I think it can be quickly adopted for student-centered learning" – T3*

Teacher 3 carried out some tasks for the teacher's workshop and after completion, it was of their opinion that the AI tool can be used to facilitate student-centered learning in a fast manner. The indication of the wish for a quick turnaround in facilitating student centered learning could be as a result of the teacher needing a lot of time to customize the courses to a student-centered learning approach. While in the case of AI, it can be leveraged to reduce the time and work load initially required for such a process.

## Theme two: Online learning environments or platforms

The online learning environments or platforms is a representation of educational technology presented to the student in an environment that is online. From the workshop, teachers voiced their opinion when asked how to use CanopyLAB as a learning platform;

> "...for online learning due to the fact that it even has a provision for social media features which make if wonderful for student learning." – T1

Teachers are aware that CanopyLAB can be used as online learning platform for them and their students. Students also point out that using an online learning environment is encouraging student interaction and offers more when compared to Moodle;

> *"Better taking on CanopyLAB since it encourages student interaction compared to Moodle"* – S1

> *"Preferably Canopy Lab due to the fact that it has more provisions of Student/Lecturer interaction than Moodle."* – S1

## Theme three: User satisfaction

User satisfaction can be defined as the degree to which the objectives of systems or the organizational unit utilizing the systems are achieved (de Pablos, 2008). User satisfaction has the following sub-themes; *dissatisfaction with the AIED tool, usefulness of an AIED tool, perceived level of intelligence, lack of clarity and continuous development of AIED tools.* With the definition of user satisfaction in mind, the users in this case are both students and teachers, the organizational unit is Gulu University and the system is the CanopyLAB platform. Both teachers and students of Gulu University voice their feedback on what they think about taking a course online on CanopyLAB. One teacher said that;

> *"Great but the recommender tools are not seen helping here."* – T1

The above statement indicates that the teacher expected the recommender tool to behave in a certain way but the system did not work as expected. CanopyLAB's recommender system can be viewed as not very efficient as its results makes the teacher see no use for it in this case. This could be discouraging to teachers when they are creating courses for their students and they might want some supplementary learning material for their students. However, this might not be the case for all teachers as it is evident that in some cases the recommender system does work well as stated by teacher 1;

> *"The exercise recommendation works quite well. However, sometimes the AI does not provide good description of the exercise"* – T1

But in the above statement, the AI also does not give the teacher a good description of the exercise as they had probably expected based on the material provided to the AI. This could mean that the CanopyLAB's AI tool may require improvement in order to work as expected.

*Perceived level of intelligence* as a sub-theme in this case would be in relation to the question of how intelligent are artificial intelligence systems. The participants interact with the AIED tool and from their own understanding of AI, they may also have a difference in what they perceive as level of intelligence in an AI tool. For example, when asked whether they would consider CanopyLAB as an AI tool - teacher one says;

> *"I consider CanopyLAB as an AI tool because it is able to intelligently analyze material from various sources to generate good learning artefacts and recommendations." -T1*

The above statement indicates that teacher 1 considers CanopyLAB to be an AI tool because it of how it was able to take the different kinds of information provided by the teacher and synthesize it into actionable results that the teacher could use in their respective courses. The teacher's comment also indicates that there is a level of satisfaction with some functionalities of CanopyLAB even though they might not all function as expected for everyone. A good example of this is when teacher 3 expresses their opinion on whether they can explain, in their own words, how CanopyLAB's AI works but they can't because the AI did not give a clear explanation to the user on how it works;

> *"The AI did not explain how it works" -T3*

## Theme four: Inclusion of marginalized groups

Inclusion of marginalized groups is in relation to groups of people who might not have been considered when the design and development of an AI tool or system. It would be naïve to assume that inclusivity is a thing that can just be fixed by quick fix solution but in reality, it may require more than that. This is why it is important to involve AIED stakeholders in the development of some of these systems. In the case of CanopyLAB, one can argue that there is some inclusion considered as there are courses in English, Spanish, Portuguese, Danish, etc. thus giving the consumer of the education material various choices to pick from and not just one specific language. However, in the Gulu University case, there is something interesting to ponder about. In Gulu University the official language is English but there are also other languages such as Luganda and Swahili which are also used in substitute of English depending on the context. Therefore, in the case of CanopyLAB, a student or teacher from Gulu University can only use it in English, as it currently does not support Luganda or Swahili. This maybe an issue in instances where a subject is taught in a local language e.g. Swahili and the content are also in Swahili but when uploaded to CanopyLAB, its AI may find a hard time analyzing the content provided as is evident in the feedback from teacher 2;

> *"Some course materials might contain local language examples which might make it difficult for the AI to analyze" – T2*

Teacher 1 also echoes a similar statement when asked what bias they think could arise from use of AI in an educational setting such as Gulu University. Teacher 1 says;

> *"Language bias - some course materials might contain local language examples which might make it difficult for the AI to analyze" -T1*

Teacher 1 and teacher 2's statements indicate that; they are aware some of the material they use may be in a local language, they are aware that local languages may be difficult for AI to analyze, and that inclusion of local dialect or language is integral in advocating for a fair and equal education when using an AIED tool.

## Theme five: Gender

Students of Gulu University were asked whether they would prefer a chatbot designed to appear as a woman (as is currently on CanopyLAB) or one that was designed to appear as a man. This was done to identify if there is a gender that students may prefer over another. Out of the four students, two women and two men, only one male student preferred female gender and the others did not mind who the chatbot was designed after as long as it was user friendly;

> *"I prefer a woman than a man since according to me women look simple" – S2*

> *"I have no problem on whether it's a man or woman as long as it's designed in a user-friendly way" – S1*

It would be interesting to look further into what the student means by "look simple" -  maybe it could be in reference to their physical appearance or is the student referring to something else. Unfortunately, the scope of this analysis does not cover this part.

Students also voiced their opinion in regards to what ethical considerations that should be put in place in order to reduce or prevent bias in AIED. One student talked about gender stereotypes and said;

> *"We should check assumptions made by each gender." – S3*

The statement above indicates that the student is aware that there needs to be ethical considerations when designing and developing these systems. By indicating that gender stereotypes would be an issue for reduction or prevention of bias as it perpetuates what is trying to be minimized or eradicated.

## Theme six: Effectiveness & ineffectiveness of AIED

There are various ways in which AIED in the context of CanopyLAB indicates that at times it is effective and at times it can also be ineffective. One way by which it is effective is that it offers teachers the opportunity to clock knowledge gaps in their students and address them as soon as they can. This is seen in the following statement made by a teacher;

> *"Teachers can use the platform to identify knowledge gaps of the students for a given topic/course unit" – T2*

Another way in which AIED is effective is by the use of meta tagging for students in order to assist them in identifying areas they have covered or may have a problem with, as this teacher pointed out;

> *"meta-tagging is useful because it helps the learner to know the area of interest or the knowledge areas that he/she is going to explore" – T3*

> *"Yes, I consider CanopyLAB as an AI tool because it is able to intelligently analysis material from various sources to generate good learning artefacts and recommendations" – T2*

Some of the ineffectiveness of AIED presents itself in the knowledge tags whereby the AI generates tags which are not related to the unit being taken and the teacher points out that;

*"knowledge tags work well, however some are not so relevant to the units." – T2*

Students at the third workshop carried out some tasks on the chatbot and pointed out that chatbot feedback was rudimentary and at times it did not give direct answers on how to proceed;

*"it did not give direct answers" – S1*

The findings of the thematic analysis present different themes based on the feedback provided by the participants.

## DISCUSSION

The findings in the chapter above can be translated into various ways but in the context of this thesis, the focus will be on teachers and students. It is evident that there are various ways in which artificial intelligence can be applied in education and the manner in which it is facilitated is important to AIED research community. For example; the learning experience is a common theme that shows teachers and students may have different ways in which they would like to approach a problem or solution and this is also evident in how the participants go about the online workshop tasks. The online experience can be categorized into different sub-categories that can be further investigated. It is also important that the online learning experience provided is also considerate of the online learning environments and platforms. User satisfaction is important to the users of AIED as they would like it to function in a certain manner. It is also interesting to see that the teachers are aware that marginalized groups can be kicked left out in educational technology and so they advocate for the involvement of educational stakeholders in order to find a middle ground whereby all parties needs or requirements are met. Gender also comes up in the discussion of the chatbot and whether the students would rather change the gender or just leave it as it is. Most of the students opt to stick with the initial option provided but there is preference of a female voice over a male voice and this might be a topic for future research. Another thing to point out is that CanopyLAB is developed in the global north and due to such there might be some aspects of it that leave out users from the global south even though there is evidence of technology developed in and by "first world" countries being used in "third world" countries with positive feedback (Nelekar et al., 2022). Investigating use of artificial intelligence in education in an African context seems to be lacking and this may be disadvantageous to the African academic and research community as they may be left behind technology-wise. Teachers do show concern for how the AI system inputs and outputs data without explaining how it has landed on the solution it provides, it would be great to see how "under the hood" of the AI looks in order to provide more information for the teachers to assess. There is also the issue about skills and literacy required to work with AI as it may be a novel thing that most people are hesitant to use. Therefore, it is salient that educational institutions in collaboration with the governments and parastatals in order to facilitate the moving forward of AIED in order for it to work. The issue about resources is also something to think about as we can see that the global south is again disadvantaged as it may not be on par with global north. As a matter of fact, we should view AIED as a way in which the inequality can be bridged between gender, social classes or any other distinctive thing that may make someone to not be considered in the use of AI which is very worrying considering where AIED is supposed to head. There is also the issue about privacy and data safety. This in itself can be considered a conundrum as it may imply that one has to choose either privacy or data. By placing one over the other, it may lead to consequences of how trustful the users are of AIED and this translates to a barrier for entry as people may not want to indulge in an online activity that puts their privacy or their data at risk. In this digital age, it is important that people know that things indeed are

required to be cognizant of their safety when using digital tools. Speaking of safety when using digital tools such as ITS, there is not that much literature on how AI can be misused in education in a manner that is critical or even risks the lives of others. So, in connection with AI literacy, data, privacy and security literacy may also be required to give the AIED users the best chance of protecting their digital identity if need be. There is also the question of where the data being used to train these AI systems in education is coming from. Data is very salient nowadays in the development of digital products but it would also be nice to know where some of the data is sourced from and if it is sourced in an ethical manner. AI that is trained on bad data will not turn that into good data instead it may even amplify all the flaws of the AIED system making users skeptical on whether to use it. There is also the point about bias in AIED, as can be seen by the feedback given by the teachers whereby they point out that biased data is not good for training AI and it might lead to users abandoning the AIED system. Developers also have to play a role in mitigating bias at the start, just before hey embark on developing AIED systems – this could be helpful in identifying pathways by which AIED systems can be developed or improved. Global north versus global south is also something to consider when developing and adapting some of these systems – there is a cultural and contextual difference that needs to be addressed or it may end up affecting the use of artificial intelligence in education.

The qualitative approach adopted does fit this master thesis project as the aim is to see, listen and understand what the Gulu University participants have to say about use of AI in education. While it fits, it is key to note that there were short comings to this approach. The qualitative nature of the online workshop means that the data collected is mostly what the participants say or note down. But in this case, the internet connectivity was hindering the discussion of the workshops as the connection was poor thus leading to multiple drop outs in connection and having to repeat. This made the recordings inaudible at some parts and thus had to suffice with the data that was sound enough to analyze and thus it is difficult to determine how much more valuable data can be in the recordings. An alternative approach would have been to use mixed methods e.g. conducting a questionnaire or survey to evaluate the participants after the participants were done with the workshops. Considering that CanopyLAB is developed in Denmark and is being used by Gulu University is in Uganda, there is the question of how would the Gulu participants want the CanopyLAB to function and how does CanopyLAB function in a context that might is out of its scope. It was also evident that the teachers seemed to be more knowledgeable about AI with some of them giving examples of the systems they have used before in relation to AI. Maybe this is because the teachers and students are from a computer science background which may have already introduced some of the artificial intelligence aspects to them. It is important to note that students from other faculties may not know about AI but that should not hinder them from trying it out and the artificial intelligence developers should ensure that they develop AI systems that can be explained in clear and concrete manner.

This means that all stakeholders of Gulu University might need to be involved in evaluation and feedback on how to design AIED for their context. AIED systems should be critically assessed by education stakeholders in a manner that is somewhat open or transparent in order to give logical feedback that can be acted upon and provide valid results.

## CONCLUSION

In conclusion, the answer to the research questions and problem statement are as follows;

**RQ1:** *What is an artificial intelligence teaching tool?*

From the literature review and analysis of the data collected from Gulu University participants, an artificial intelligence teaching tool is educational software or digital tool that can be used by teachers for teaching, identifying knowledge gaps, develop and publish courses, etc. A teaching tool can also be having a student or learner section whereby students can use.

**RQ2:** *How are teachers and students using artificial intelligence as a tool to support their teaching and learning?*

Teachers are using AI in education to assist them in the process of developing their educational content and assessing knowledge gaps in students. As for the students, they can use AI to help them undertake the assignments provided by their teachers.

**RQ3:** *What kind of issues, inequalities & partialities arise from use of artificial intelligence as a teaching tool and how to create and use educational content powered by artificial intelligence that considers or mitigates these issues, inequalities and partialities?*

Based on this thesis research, gender and marginalizing of underprivileged communities are the main issues that cause inequalities and partialities because AIED developers may not be involving these communities when they indeed need to in order to produce sound results. In order to mitigate said issue, it is integral to involve the stakeholders of AIED as their opinions, feedback, concerns will be required.

**RQ4:** *How can we design artificial intelligence tools for education in a way that encourages its use by teachers and students?*

It can be seen from the data analysis of this report that teachers and students both show discontent in how the AI operates at times, e.g. the rudimentary level at which they deem it to be and no explanation as to how the AI works. It is important to foster trust of the teachers and students in AI so that they are motivated to use artificial intelligence in education.

***Problem statement:*** *"How is artificial intelligence being used in education to support students and teachers in their teaching, and what are the bottlenecks & barriers?"*

Artificial intelligence is used in education in various ways such as; for teachers to developing educational content for the students, identifying knowledge gaps in students and sometimes providing support for students if teacher is not available. The bottlenecks and barriers identified are rudimentary capability of AI may not motivate the users, a stable internet connection is required and some communities may not be privileged enough to access internet. There is also the need to develop humanistic artificial intelligence in education. However, what seems to be the main barrier or bottleneck based on this Gulu University research is minimal involvement of the global south in the development of artificial intelligence in education thus making them somewhat invisible to the rest of the leading first world countries which have a heightened interest in artificial intelligence in education (Chen et al., 2022).

Future work of AIED could include in depth research on how artificial intelligence is used in an African higher education context in order to grasp the AIED awareness or literacy levels present in the potential users. Involvement of the company offering the artificial intelligence in education tool with educational institutions and  possibly the respective governments may be required to work in collaboration in order to achieve the goal of explainable, fair AI that is developed with the human being (teacher or student) in mind. More research into

the theoretical implications of AIED could also be helpful and assistive in the long run as it can be translated to actionable results by teachers or students.

# References

Alamri, H. A., Watson, S., & Watson, W. (2021). Learning Technology Models that Support Personalization within Blended Learning Environments in Higher Education. *TechTrends*, *65*(1), 62–78. https://doi.org/10.1007/s11528-020-00530-3

Al-Badi, A., Khan, A., & Eid-Alotaibi. (2022). Perceptions of Learners and Instructors towards Artificial Intelligence in Personalized Learning. *Procedia Computer Science*, *201*, 445–451. https://doi.org/10.1016/j.procs.2022.03.058

Baker, T., Smith, L., & Anissa, N. (2019). *Exploring the future of artificial intelligence in schools and colleges* (pp. 1–52). Nesta. https://media.nesta.org.uk/documents/Future_of_AI_and_education_v5_WEB.pdf

Bates, T., Cobo, C., Mariño, O., & Wheeler, S. (2020). Can artificial intelligence transform higher education? *International Journal of Educational Technology in Higher Education*, *17*(1), 42, s41239-020-00218–x. https://doi.org/10.1186/s41239-020-00218-x

Birt, L., Scott, S., Cavers, D., Campbell, C., & Walter, F. (2016). Member Checking: A Tool to Enhance Trustworthiness or Merely a Nod to Validation? *Qualitative Health Research*, *26*(13), 1802–1811. https://doi.org/10.1177/1049732316654870

Blanchard, E. G. (2015). Socio-Cultural Imbalances in AIED Research: Investigations, Implications and Opportunities. *International Journal of Artificial Intelligence in Education*, *25*(2), 204–228. https://doi.org/10.1007/s40593-014-0027-7

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Bryman, A. (2016). *Social research methods* (Fifth Edition). Oxford University Press.

Chen, X., Xie, H., Zou, D., & Hwang, G.-J. (2020). Application and theory gaps during the rise of Artificial Intelligence in Education. *Computers and Education: Artificial Intelligence*, *1*, 100002. https://doi.org/10.1016/j.caeai.2020.100002

Chen, X., Zou, D., Xie, H., Cheng, G., & Liu, C. (2022). Two Decades of Artificial Intelligence in Education: Contributors, Collaborations, Research Topics, Challenges, and Future Directions. *Educational Technology & Society*, *25*(1), 28–47.

de Pablos, C. (2008). Shared Networks in Technology Education: In L. A. Tomei (Ed.), *Encyclopedia of Information Technology Curriculum Integration* (pp. 758–763). IGI Global. https://doi.org/10.4018/978-1-59904-881-9.ch118

Dias, S. B., & Bidarra, J. (2020). A/B/C-TEACH Framework: The Application of AI in Blended Learning. In G. Ubachs (Ed.), *The Envisioning Report for Empowering Universities* (pp. 22–24). European Association of Distance Teaching Universities, The Netherlands. https://tinyurl.com/empower-report-2020

Fortune Business Insights. (2020, July). Artificial Intelligence (AI) Market Size, Share & COVID-19 Impact Analysis, By Component (Hardware, Software, and Services), By Technology (Computer Vision, Machine

Learning, Natural Language Processing, and Others), By Deployment (Cloud, On-premises), By Industry (Healthcare, Retail, IT & Telecom, BFSI, Automotive, Advertising & Media, Manufacturing, and Others) and Regional Forecast, 2020-2027. *Artificial Intelligence Market Size, Growth, Share | Analysis [2020-2027]*. https://www.fortunebusinessinsights.com/industry-reports/artificial-intelligence-market-100114

Gupta, S., & Chen, Y. (2022). Supporting Inclusive Learning Using Chatbots? A Chatbot-Led Interview Study. *Journal of Information Systems Education*, *33*(1), 98–108.

Holmes, W., Bialik, M., Fadel, C., & Center for Curriculum Redesign. (2019). *Artificial intelligence in education: Promises and implications for teaching and learning*. Center for Curriculum Redesign.

King, N. (2004). Using Templates in the Thematic Analysis of Text. In C. Cassell & G. Symon, *Essential Guide to Qualitative Methods in Organizational Research* (pp. 256–270). SAGE Publications Ltd. https://doi.org/10.4135/9781446280119.n21

Kochmar, E., Vu, D. D., Belfer, R., Gupta, V., Serban, I. V., & Pineau, J. (2022). Automated Data-Driven Generation of Personalized Pedagogical Interventions in Intelligent Tutoring Systems. *International Journal of Artificial Intelligence in Education*, *32*(2), 323–349. https://doi.org/10.1007/s40593-021-00267-x

Kumar, A., Singh, N., & Jyothi-Ahuja, N. (2017). Learning styles based adaptive intelligent tutoring systems: Document analysis of articles published between 2001. and 2016. *International Journal of Cognitive Research in Science, Engineering and Education*, *5*(2), 83–97. https://doi.org/10.5937/ijcrsee1702083K

Li, H., & Wang, H. (2020). Research on the Application of Artificial Intelligence in Education. *2020 15th International Conference on Computer Science & Education (ICCSE)*, 589–591. https://doi.org/10.1109/ICCSE49874.2020.9201743

Lind, J., Ghirlanda, S., & Enquist, M. (2019). Social learning through associative processes: A computational theory. *Royal Society Open Science*, *6*(3), 181777. https://doi.org/10.1098/rsos.181777

Lo, J.-J., Chan, Y.-C., & Yeh, S.-W. (2012). Designing an adaptive web-based learning system based on students' cognitive styles identified online. *Computers and Education*, *58*(1), 209–222. https://doi.org/10.1016/j.compedu.2011.08.018

Maguire, M., & Delahunt, B. (2017). Doing a Thematic Analysis: A Practical, Step-by-Step Guide for Learning and Teaching Scholars. *AISHE-J: The All Ireland Journal of Teaching and Learning in Higher Education*, *Vol.9(3)*, 14.

Markets and Markets. (2018, May). AI in Education Market by Technology (Deep Learning and ML, NLP), Application (Virtual Facilitators and Learning Environments, ITS, CDS, Fraud and Risk Management), Component (Solutions, Services), Deployment, End-User, and Region—Global Forecast to 2023. *AI in Education Market*. https://www.marketsandmarkets.com/Market-Reports/ai-in-education-market-200371366.html

Miao, F., Holmes, W., Huang, R., Zhang, H., & Unesco. (2021). *AI and education: Guidance for policymakers.*

Ministry of Higher Education and Science, Denmark. (2014). *Danish Code of Conduct for Research Integrity*. Ministry of Higher Education and Science. https://ufm.dk/en/publications/2014/files-2014-1/the-danish-code-of-conduct-for-research-integrity.pdf

Nelekar, S., Abdulrahman, A., Gupta, M., & Richards, D. (2022). Effectiveness of embodied conversational agents for managing academic stress at an Indian University (ARU) during COVID-19. *British Journal of Educational Technology*, *53*(3), 491–511. https://doi.org/10.1111/bjet.13174

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic Analysis: Striving to Meet the Trustworthiness Criteria. *International Journal of Qualitative Methods*, *16*(1), 160940691773384. https://doi.org/10.1177/1609406917733847

Ørngreen, R., & Levinsen, K. (2017). Workshops as a research methodology. *EJEL. Electronic Journal of E-Learning*, *15*(1), 70–81.

Pedro, F., Subosa, M., Rivas, A., & Valverde, P. (2019). *Artificial intelligence in education: Challenges and opportunities for sustainable development*. http://repositorio.minedu.gob.pe/bitstream/handle/20.500.12799/6533/Artificial%20intelligence%20in%20education%20challenges%20and%20opportunities%20for%20sustainable%20development.pdf?sequence=1&isAllowed=y

Qin, F., Li, K., & Yan, J. (2020). Understanding user trust in artificial intelligence-based educational systems: Evidence from China. *British Journal of Educational Technology*, *51*(5), 1693–1710. https://doi.org/10.1111/bjet.12994

Renz, A., & Vladova, G. (2021). Reinvigorating the discourse on human-centered artificial intelligence in educational technologies. *Technology Innovation Management Review*, *11*(5), 5–16. https://doi.org/10.22215/TIMREVIEW/1438

Schiff, D. (2021). Out of the laboratory and into the classroom: The future of artificial intelligence in education. *AI & Society*, *36*(1), 331–348. https://doi.org/10.1007/s00146-020-01033-8

Sharma, P., & Harkishan, M. (2022). Designing an intelligent tutoring system for computer programing in the Pacific. *Education and Information Technologies*, *27*(5), 6197–6209. https://doi.org/10.1007/s10639-021-10882-9

Solomonoff, R. J. (1985). The time scale of artificial intelligence: Reflections on social effects. *Human Systems Management*, *5*(2), 149–153. https://doi.org/10.3233/HSM-1985-5207

Taherdoost, H. (2016). Sampling Methods in Research Methodology; How to Choose a Sampling Technique for Research. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3205035

Thapliyal, M., Ahuja, N. J., Shankar, A., Cheng, X., & Kumar, M. (2022). A differentiated learning environment in domain model for learning disabled learners. *Journal of Computing in Higher Education*, *34*(1), 60–82. https://doi.org/10.1007/s12528-021-09278-y

Timms, M. J. (2016). Letting Artificial Intelligence in Education Out of the Box: Educational Cobots and Smart Classrooms. *International Journal of Artificial Intelligence in Education*, *26*(2), 701–712. https://doi.org/10.1007/s40593-016-0095-y

Wang, F.-Y., Zhang, J. J., Zheng, X., Wang, X., Yuan, Y., Dai, X., Zhang, J., & Yang, L. (2016). Where does AlphaGo go: From church-turing thesis to AlphaGo thesis and beyond. *IEEE/CAA Journal of Automatica Sinica*, *3*(2), 113–120. https://doi.org/10.1109/JAS.2016.7471613

Wang, S., Yu, H., Hu, X., & Li, J. (2020). Participant or spectator? Comprehending the willingness of faculty to use intelligent tutoring systems in the artificial intelligence era. *British Journal of Educational Technology*, *51*(5), 1657–1673. https://doi.org/10.1111/bjet.12998

Wei, M. (2022). The Design of Intelligent Tutoring Systems Using College Students' Innovation and Entrepreneurship Education under the Background of Online Teaching. *Wireless Communications and Mobile Computing*, *2022*, 1–9. https://doi.org/10.1155/2022/9180933

Yuce, A., Abubakar, A. M., & Ilkan, M. (2019). Intelligent tutoring systems and learning performance: Applying task-technology fit and IS success model. *Online Information Review*, *43*(4), 600–616. https://doi.org/10.1108/OIR-11-2017-0340

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – where are the educators? *International Journal of Educational Technology in Higher Education*, *16*(1), 39. https://doi.org/10.1186/s41239-019-0171-0