Investigating the Impact of AI-Powered Digital Educational Platforms on Students' Learning and Teachers' Practice in Abu Dhabi Schools

استكشاف أثر المنصات التعليمية الرقمية المدعمة بتقنيات الذكاء الاصطناعي على
أداء الطلبة وممارسات المعلمين في مدارس أبوظبي

by

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Abstract

The purpose of this study is to shed light on the investigation of the impact and influence of AI-powered digital learning platforms on student learning and teacher practice and to show the role of these platforms amidst the COVID-19 pandemic. The study also proposes the best practices of using AI-enabled learning platforms for both the student and the teacher to achieve the learning outcomes and improve student learning. To measure this impact, the researcher applies the mixed method approach – qualitative and quantitative – to arrive at comprehensive, accurate and reliable findings. The research sample consists of 7039 students in 12 public schools and 512 teachers in schools across the Emirate of Abu Dhabi in the UAE. The sample is divided into two groups, where one group started implementing the Alef Platform a year ahead of the other group. The thesis presents evidence of the difference in the performance between those two groups and found a positive correlation between students' learning and engagement with the Alef Platform and the results they achieved. Moreover, the thesis shows that activating the Alef Platform helped develop the teachers’ performance, reduced their workload and transformed their role from traditional instructors into facilitators and coaches. This thesis also asserts the importance of professional development for teachers and school administrators and recommends them to continue training to be able to fully utilize the features of such platforms. The researcher also proposes that Alef Platform adds the remaining school subjects and that the Platform is defined as a national and global project inclusive of all school subjects from grade 1 up to grade 12, with the aim of creating a comprehensive virtual learning ecosystem to support and ensure the continuation and sustainability of learning in cases of natural disasters anywhere around the world.

الملخص

إن الغرض الرئيسي من هذه الدراسة هو تسليط الضوء على عملية استكشاف أثر المنصات التعليمية المدعمة بتقنيات الذكاء الاصطناعي على أداء الطلبة وممارسات المعلمين وتبحث في دور هذه المنصات في ظل انتشار جائحة كورونا. كما تهدف الدراسة إلى طرح أفضل الممارسات لاستخدام هذه المنصات بالنسبة للطلبة والمعلمين بما يساهم في تحسين تعلم الطلبة. للعمل على قياس هذا الأثر، استخدم الباحث منهجية البحث العلمي المختلط الذي يجمع بين البحث الكمي والنوعي للتوصل إلى نتائج دقيقة وشاملة وموثوقة. تضم عينة البحث 7039 طالب وطالبة يلتحقون في 12 مدرسة حكومية و512 معلم ومعلمة يعملون في هذه المدارس الموزعة في جميع مناطق إمارة أبوظبي في الإمارات العربية المتحدة. تم تقسيم العينة إلى مجموعتين بحسب السنة الدراسية التي تم فيها بدء تطبيق منصة تعليمية تعتمد على الذكاء الاصطناعي، بحيث بدأت المجموعة الأولى في استخدام المنصة قبل المجموعة الثانية بعام دراسي كامل. يشتمل البحث على أدلة تبين الفرق في أداء الطلبة في كل من المجموعتين وتوصل البحث إلى أن هنالك علاقة إيجابية بين تفعيل الطلبة للمنصة والنتائج التي حققوها، الأمر الذي يثبت أن تعلم الطلبة على المنصة يؤدي الى تحسين أدائهم الدراسي والسلوكي وقدرتهم على التعلم الذاتي والمستقل. كما يظهر البحث أن استخدام التكنولوجيا وتقنيات الذكاء الاصطناعي في المدرسة يساهم في زيادة تفاعل الطلبة مع المحتوى التعليمي ويزيد من قدرتهم على التعلم الذاتي والمستقل. كما أثبت البحث أن تفعيل منصة ألف للتعليم طور من أداء المعلمين وخفف عنهم الأعباء الروتينية ووجه دورهم ليبتعدوا عن الدور التقليدي للمعلم ليصبح المعلمون مسهلين وموجهين للعملية التعليمية. مع ذلك، يؤكد البحث أنه من الضروري للغاية الاستمرار في تدريب المعلمين والإداريين على أفضل ممارسات استخدام وتطبيق هذه المنصات. يختتم الباحث الدراسة بتوصية المعلمين بالاستمرار في التدرّب ليتمكنوا من تحقيق الاستفادة القصوى من الخصائص المبتكرة المتوفرة في مثل هذه المنصات والتي تم تصميمها للتوفير من وقت وجهد المعلمين ليتسنى لهم توجيه اهتمامهم على تحقيق الاحتياجات التعليمية لكل طالب بشكل فردي. كما يقترح الباحث ضم جميع المواد الدراسية في المنصة وزيادة الأنشطة والتجارب العلمية ذات خاصية الواقع الافتراضي واعتماد المنصة كمشروع وطني وعالمي يضم جميع المواد التعليمية من الصف الأول حتى الصف الثاني عشر وفق معايير ومخرجات تعلم ثابتة لتشكيل منظومة تعليمية افتراضية عالمية تضمن الاستدامة وتحد من توقف العملية التعليمية وقت الأزمات والكوارث.

Dedication

To His Highness Sheikh Mohammed bin Zayed Al Nahyan, the inspiring leader who instilled loyalty, belonging and the love to giving into the citizens of our nation… to the leader that time rarely grants us with

To His Highness Sheikh Hazaa bin Zayed Al Nahyan… Whose futuristic vision is the guidance of the nations' posterity… To whom this achievement is devoted, and whose words were the inspiration that led to this thesis.

إهداء

إلى صاحب السمو، الشيخ محمد بن زايد آل نهيان القائد الملهم الذي زرع الولاء والانتماء وحب العطاء في أبناء هذا الوطن، إلى من قل أن يجود الزمان بمثله أهدي هذا الإنجاز.

وإلى سمو الشيخ هزاع بن زايد آل نهيان... إلى من استشرف آفاق المستقبل للأجيال المقبلة، إلى من كان المحفز والدافع الأول لتحقيق هذا الإنجاز، إلى من صاغت حروف كلماته واقع هذه الأطروحة.

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Table of Contents

List of Tables

List of Figures

List of Charts

Appendices

Abbreviations

UAE	United Arab Emirates
MOE	Ministry of Education
ADEK	Abu Dhabi Department of Education and Knowledge
SA	Summative Assessment
AI	Artificial Intelligence
KG	Knowledge Graph
TIMSS	Trends in International Mathematics and Science Study
CBM	Curriculum-Based Measurement

Definitions

Artificial Intelligence	The simulation of human intelligence in machines that are programmed to think like humans and mimic their actions. The term may also be applied to any machine that exhibits traits associated with a human mind, such as learning and problem-solving.
Adaptive Learning	A method that uses software as an intelligent interactive teaching mechanism that combines the provision of resources according to the unique and essential learning requirements of each student.
AI-powered digital educational platforms	Any platform that applies any kind of AI software or application such as; automated grading systems, adaptation software which can identify the individual need and student level and guide them to the suitable courses, any software can identify where a student struggles and provide direct and immediate feedback and specific support to this student, such as extra assistance or automated tutors.
The Alef Platform	An interactive AI-powered digital learning platform offered to teachers, students, principals, and guardians.
Knowledge Graph	A knowledge graph (i) mainly describes real-world entities and their interrelations, organized in a graph, (ii) defines possible classes and relations of entities in a schema, (iii) allows for potentially interrelating

	arbitrary entities with each other and (iv) covers various topical domains.

CHAPTER 1:

INTRODUCTION

1.0 Introduction

Governments, ministries of education and policymakers all around the world are ceaselessly seeking to transform the educational system to fulfil the new generation's educational needs and be better equipped to leverage the emerging technologies to eventually provide an advanced educational system that prepares the students to the required skillsets for the future.

The quality of education is one of the pillars of the United Arab Emirate's Centennial 2071, as the country aims to implement a high-quality education with a focus on the sciences of the future, such as space science, engineering, innovation and health sciences, among others. The UAE aims to develop the students' ability to bring out the inner capabilities that they excel at. This vision also involves developing educational institutions to play an entrepreneurial role in the education sector by becoming incubators and global research centres.

Education in the UAE is also considered an indispensable sector to its National Agenda 2021 as it plays a critical role in achieving economic and social success for all countries around the world today (Al-Gumaei et al. 2019). In order for new generations to gain 21st-century skills, the UAE leaders and policymakers have been working to reform the education system and spending billions of Dirhams to prepare the youth for future demands (Al-Gumaei et al. 2019). The UAE National Agenda "aims for all schools, universities and students to be equipped with smart systems and devices as a basis for all teaching methods, projects and research" (First-Rate Education System 2019 p.1). Subsequently, the UAE Ministry of Education (MOE) announced its vision and set of values, which highlighted the influence of technology on teaching and learning (Al-Gumaei et al. 2019). The UAE has the vision to become a world leader in AI by 2031 - with this goal on its agenda, the UAE government established an AI Ministry, a national program and a strategy dedicated to Artificial Intelligence. The major task of all these entities is to invest in the latest AI technologies and tools to enhance the UAE government's performance and efficiency. The UAE went further ahead and established an AI strategy, "The UAE Strategy for Artificial Intelligence". Through this strategy, the UAE aims to enhance the students' desire for education and encourage them to make learning an integral part of their everyday life.

Artificial intelligence in digital learning has the potential to radically change the way of teaching and learning in schools, but there is an ongoing argument as to what extent this impacts both the student and the teacher. There are three main principles that define the efficiency of using technology in education, namely: what type of technology is being used, the methods of learning and how the teacher utilizes this technology (Olive 2011). Clark (1983) claims that "technologies are merely vehicles that deliver instruction, and do not themselves influence student achievement" (Clark 1983; Anderson 2008 p.15). Today, the internet enables students to access and interact with the well-planned, high-quality learning material anywhere and anytime; it also enables teachers to provide their students with the needed support; technology enables the teacher and the student to create an understanding of the student's academic progress and knowledge growth (Ally 2008).

The huge and rapid growth of new educational technology tools has completely changed the traditional methods of teaching and learning (Mentis 2008). According to Macleod et al. (2014), technology improves and supports the ways and approaches of teaching and learning. A Digital learning environment provides an opportunity for teachers to promote effective pedagogy (Jesson, McNaughton, Rosedale, Zhu, & Cockle 2018). However, the implementation of a new teaching method using AI-powered digital learning ultimately improves the students' education and helps them progress. However, one of the main challenges that have to be considered is the teachers and how they receive and utilize this new system. Veteran teachers, who are usually not attached to technological devices as they are not used to depending on them as most people do now, might find it extremely challenging to handle the new teaching system. Therefore, extensive training for the teachers must be conducted until they master using the platform to the best of their abilities. Once they are confident that they can fully operate within the new system, each teacher can know how and when to use the platform and come up with their own creative way of optimally utilizing it for their own and the students' good.

Using digital learning technology helps teachers to improve their lesson plans and to become better educators (Ocumpaugh et al. 2017). According to Baker (2018), the integration of technology in schools influences the teacher and the student; students have more engagement with technology and teachers’ practices are changed.

The Ministry of Education in the UAE started to implement an AI-powered digital learning system in its schools in Abu Dhabi using the AI-driven Alef Platform as of 2017 (Alef Education 2020). Alef Education provides a 1:1 laptop with the AI-driven platform, called the Alef Platform, pre-installed as well as the needed internet access to schools. It also provides training for teachers on how to implement the Alef Platform and blended learning in the classroom.

In early 2016, Alef Education company was established in Abu Dhabi in the UAE to develop a holistic digital educational system called the Alef Platform, which is powered by artificial intelligence technologies (Alef Education 2020). The Alef Platform is currently being used by all public schools in the UAE from grade 5 to grade 11, with plans to expand and cover grade 12 in September 2021 as well as in a number of private schools across the United Arab Emirates. The Alef Platform is also implemented on an international level in a number of schools in New York, United States of America, starting in 2018 with Harlem Children Zone Schools (HCZ), from which it expanded to cover other schools across the state, in addition to another school in Nova Scotia, Canada (Alef Education 2020). In the UAE, the Alef Platform transforms the MOE's curriculum in the six core subjects (Arabic language, English language, science, math, Islamic studies and social studies) into digital content. On the Alef Platform, each subject is divided into many mini-lessons that are aligned with the MOE's curriculum pacing guide; each mini-lesson is designed within a well-studied framework, starting with The Big Idea, followed by different activities that range in difficulty levels in accordance with Bloom's taxonomy depths of knowledge, each of which ends with a formative assessment and each mini-lesson ending with a summative assessment. The Alef Platform provides immediate feedback and hints to the student while taking the formative and summative assessments as part of the learning process. According to Baker et al. (2018), the Alef Platform is based on conceptual processes and offers practice opportunities and direct feedback to promote reflecting on what students have learned, and also offers real-time data for teachers and administration about student work. The Alef Platform provides teachers and students with ready learning materials that start with the Big Idea up to the summative assessment (Exit Ticket); these include different resources, such as videos, stories, games, simulation activities and reading and writing activities. The Alef Platform also provides the teachers with immediate and live data on their students' behavioural and academic performance. Alef Education company provides a training platform called the Alef Academy, which is a part of the teachers' journey in the Alef Platform and a professional team of coaches dedicated to training teachers on the ideal usage of the Alef Platform, whether face-to-face or digital using this academy.

This thesis aims to explore the impact of implementing AI-enabled digital learning on the performance of both the student and the teacher. The case study of this thesis is the Alef Platform, an digital learning platform that has recently been implemented across the UAE since its start in 2017. Therefore, this thesis studies the impact of the Alef Platform on student performance and engagement as well as how this platform changes teachers' practice and transforms their role. In addition to that, the thesis aims to measure the role that the platform plays amidst natural disasters, such as the current situation with COVID-19 in Abu Dhabi schools in the United Arab Emirates.

The Alef Platform was piloted in one school during the academic year of 2017/2018. The students showed promising improvement by the end of the first year, which led the Ministry of Education to decide on implementing the platform in ten more schools in the following academic year of 2018/2019 (Alyammahi 2019).

The rationale of this study is that digital learning in the UAE is just starting, which calls for more research to be done to make sure students benefit from it and to provide the optimized practice of teaching using digital and AI-powered teaching methods. Previous research is available on E-learning and digital learning on an international basis; however, not enough research has been conducted in the UAE; this study represents a contribution to be added to the educational studies, as Shafer (2017) mentioned, research on eLearning and digital learning needs to be conducted in different countries and different cultures (Shafer 2017). In addition, more research is needed to be conducted on the provision of AI-powered learning platforms, particularly since artificial intelligence has recently emerged as a tremendous asset to the implementation of digital education.

The mixed-method approach is applied in this thesis in 12 different schools, 6 of which started implementing the Alef Platform in 2018, and the remaining six schools started using the Alef Platform in 2019. The study is carried out using both qualitative and quantitative methods to help provide a deep and wide understanding (Creswell 2009). The sample size includes 7,039 students and 512 teachers, adding high value to the result of investigating the relationship between the implementation of the AI-powered digital learning (the Alef Platform) and its influence and impact on student learning and teacher practice in Abu Dhabi primary and secondary schools.

The key results of this study found that there is a strong relationship between the students' usage of the Alef Platform and their engagement with its content, and the progress that students achieve. The findings of the study also support the integration of technology in education as a way to raise student engagement and participation. The thesis also shows how the implementation of the Alef Platform supports the teachers by taking off their shoulders the routine daily tasks, allowing teachers to make more time to focus their attention on the individual needs of their students. Finally, the study touches upon the role of digital learning platforms in general, and the Alef Platform in particular, in times of natural disasters where learning inside the school is not possible and where such platforms ensure that student learning does not stop.

1.1 Problem statement of the study

There are many problems and reasons to study AI-driven digital learning; firstly, AI-driven digital learning was launched to continue and grow very fast, and it will keep improving and spreading everywhere to transform the educational systems up to the extent that there is no going back to the traditional teaching and learning methods (Mucundanyi 2019). Secondly, the number of students who use distance learning is increasing, and the need for digital learning and distance learning is increasing especially with the COVID-19 pandemic where many schools all over the world closed, and education activities were interrupted, according to Adnan and Anwar (2020) “this was not the first time when conventional education activities were suspended. SARS coronavirus (SARSCoV) also negatively impacted conventional education activities of a large number of countries around the globe and not just SARS-CoV but the H1N1 Flu outbreak also negatively impacted education activities in 2009” (p.45). Thirdly, the Emirate of Abu Dhabi in the UAE has spent millions of dollars to bring the 1:1 laptop program (the Alef Platform) and internet access to schools. The Ministry of Education in the UAE has dedicated significant spending and effort to improve student performance as in 2015, TIMSS showed a weakness in students’ performance in math and science in the UAE. This pushed decision-makers to find creative solutions that help the UAE to support improving student performance and skills (TIMSS 2015 and TIMSS Advanced 2015 International Results – TIMSS Reports 2020). According to Subrahmanian (2017), AI prediction systems can predict the problem before it occurs, which can be fixed in real-time with the support and supervision of human staff in order to avoid such problems (Subrahmanian 2017). Such prediction systems can project the students' struggles and the skills that each student lacks, and with the necessary supervision from the teachers, the students can be provided with the needed support in time to overcome their educational challenges. Enhanced student engagement with digital learning improves student learning. Furthermore, student engagement grows the student’s satisfaction (Mucundanyi 2019). The UAE's “Vision 2021 National Agenda" emphasizes the development of a first-rate educational system, and this requires a complete transformation of the current education system and teaching methods. In the UAE, technology is used to motivate student engagement and improve the key 21st-century skills for learning. According to Matsumoto (2019), there is a big gap in educational research in the UAE; hence the need arises for more research to be done. As the implementation of the Alef Platform started just a few years ago, this is the first study to cover AI-driven digital learning platforms in the UAE, which is considered an under-researched area globally, particularly in the UAE.

This thesis is significant as it investigates the impact of the newly implemented AI-driven digital platforms on the two most significant pillars of the education sector, the students and the teachers. Knowing the results and the understanding of the factors that contributed to acquiring the positive impact for both pillars, teachers and students, can help instructional, curriculum and product designers to enhance the product and the content according to the findings of the thesis. The findings of this research might contribute to the exploration of the best teachers' practices toward the implementation of the Alef Platform, which eventually leads to an optimized learning environment.

The AI-driven digital platform has positive and negative impacts on people's lives; the main concern of this study is to reduce and minimize the negative impact of digital learning on student learning and to increase the advantages it may bring to students. According to Sung and Hwang (2017) digital learning increases students' achievement and improves their ability to learn. According to Shafer (2017), implementing AI-enabled platforms can increase the benefits; however, they need to be used in all areas of education, and that could be challenging.

Using an AI-enables platform has been carried out to integrate technology education as a solution to improve student performance. However, it has to be well-designed and implemented in a way that affects student learning positively (Shafer 2017). According to Baker (2018), the Alef Platform content could be effective or less effective, but with the data provided from the platform, it becomes easier to detect which parts of the content are less effective and contact the developer to review it; the teacher can also utilize the data provided by the platform to make sure that students comprehend the material and if not, take action upon that. A key feature of these software systems is their ability to record and store every activity taken during the learning process. The software of the platforms continuously collects and analyzes data while students access and use the platform. This data helps create a report on the progress and learning behaviour of each individual student, the class and ultimately the school as a whole, which enables educators to create an action plan as needed on the level of each individual student, class, or the whole school, (Ally 2008).

As Kavitha and Raj (2017) suggested, the big data that is collected from education software helps to improve the learning process easily. According to Yang et al. (2016), the big data on students' work that is collected through technology helps to track students' progress and performance. This research is significant to ensure that the digital learning that Alef education provides is used in ways that advance student learning and ensure there are no negative side effects. The main purpose of this study is to investigate the impact of digital learning in improving student learning and teachers' practice in Abu Dhabi primary and secondary schools.

Sometimes, people tend to have a cautious and doubtful reaction towards change, especially when it includes technology. Despite the fact that technology and smart devices have become a part of our daily lives, there are a few concerns about including it in the learning process as well. The most common concern that people tend to point out is the devices' impact on students' eyes. Having a screen/monitor in front of a child for a long period is not healthy; there is no denying that.

Therefore, to protect the students, such platforms should be used for part of the lesson and not throughout the classes. Keeping intervals between each class allows the eyes to take rests and protects them from any negative effect the monitors may pose. Another concern is the social life of the students. If the student can learn all that he needs from a device that they can take with them wherever they want to, what would encourage this student to communicate with their teacher and classmates or even bother to come to school? This is a valid concern that all EdTech companies should address. Using the example of the Alef Platform, the students are instructed to use the platform for 20 to 25 minutes during each class. After that, the student is requested to pay attention to the teacher and start working with their classmates in groups to do an activity and then share it as a group with the rest of the class. This should contribute to solving both concerns effectively and, at the same time, help improve the student's education and level of knowledge. That’s why the researcher aims to study the teacher’s practice and confirm whether the teacher follows the procedure and, if yes, whether the procedure mentioned above is effective. Normally, teachers and students have different perspectives and approaches to the best teaching and learning methods using a digital platform. For example, some teachers prefer to use blended learning, flipped classroom, and/or other learning styles. According to WOGU et al. (2019), the negative perspective that AI innovations and their importance to the education system is seen with should be shifted to a positive one as scholars are increasingly calling to reconsider the role of AI-driven technology in the education sector. As mentioned by WOGU et al. (2019), technology and AI are seen as unnecessary replacements of teachers that steal away the teachers’ significant role as educators and that such systems channel the work towards the parents away from the teachers. Additionally, WOGU et al. state that these platforms are observed as machines that were not designed to be responsible for teaching students, a task that is highly sensitive and requires professional capabilities to teach the students (WOGU et al. 2019).

Tarus et al. (2015) define blended learning as “the thoughtful fusion of face-to-face and digital learning experiences” (P. 121). Miller, Baker and Rossi (2014) suggest that students with a digital education system need to work on different class activities, such as blended learning, rather than working on a single activity using the laptop, for instance.

According to Melzer, P. (2019), the evaluation instruments in previous studies on e-learning often focus on learning or on how teachers use e-learning, and they lack focus on the combination of both. Therefore, this study focuses on both angles: student learning and teacher practice. This research touches upon the relationship between student psychology, such as motivation and engagement and AI-powered digital platforms. According to Anderson & Schunn (2000), there is a link between cognitive psychology and education that needs more exploring and research to be conducted in order to come up with key results that help student learning (Anderson & Schunn 2000).

1.2 Purpose of the study

The main purpose of this study is to investigate the impact and influence of AI-powered digital learning platforms on student learning and teacher practice. There are three core objectives: first, student learning - the impact of AI-driven digital educational platforms on developing students’ engagement with the learning material, personalized and independent learning, and learning progress. The second core objective is to investigate if AI-powered digital educational platforms change teachers' role inside the classroom or not. Accordingly, the aim is to understand the teachers' perspective toward using AI-powered digital educational platforms and to find out the challenges that students and teachers face with the implementation of these platforms. The third objective of this study is to understand how these platforms help the education field to support continued distance learning post-COVID-19.

This study aims to provide a brief overview of reflections and lessons learned from implementing AI-driven systems in primary and secondary schools in the UAE and presenting the best practices of this AI-driven platform by teachers and students, and explore the boundaries and obstacles that limit the maximum benefit of this platform and turn these boundaries into promising opportunities. Additionally, this study proposes the right methods of implementing AI-powered digital learning platforms for all stakeholders, including the Ministry of Education, school leaders, teachers, students and parents, to support the Education Sector and achieve the 2031 UAE AI Vision and help them to establish a unified and advanced national educational system to ensure that the ideal AI-adopting teaching and learning method fulfils the UAE AI vision for the year 2031 to be one of the first countries to adopt artificial intelligence in every sector.

1.3 Research questions

The researcher aims, through the research questions listed below, to discuss in-depth and measure the impact of AI-enabled platforms on students' engagement with learning and, in turn, their academic and behavioural performance. The below questions also aim to look into and assess how such AI-driven systems can help teachers and administrators by conducting a dedicated survey to collect actual feedback from teachers who use these systems. Additionally, and in light of the recent and un-forecasted situation with the COVID-19 pandemic, the researcher attempts to measure the significance of the contribution that digital learning systems provided in a situation where education could have been inevitably stopped.

The main research questions are as follows:

1. How does AI-driven digital learning improve students' learning?
2. What are the teachers' perceptions of AI-powered digital learning platforms?
3. How does the implementation of AI in digital learning impact teachers' practice?
4. How do AI-powered digital learning platforms help students and teachers during Coronavirus (COVID-19) pandemic?

The first question addresses the way AI-enabled learning platforms can improve students' learning. To reach an extensive answer, the researcher looks into the time that students spend on such platforms, such as the Alef Platform, and the scores students achieve on the platform and try to define the relationship (if any) between that and the students' results in the official centric exams that are conducted by the UAE's Ministry of Education. The researcher also draws a comparison between two groups of students who use the Alef Platform where one group starts a year ahead of the other group; this comparison looks into the students' scores on the platform as well as the official ministerial exams. The question also addresses the students' engagement which the researcher aims to answer by studying the relationship between the total time students spend on each stage of the Alef Platform's lesson and the score the student acquires in the formative assessment, which is also conducted as part of the Alef Platform's lesson. The researcher compares the total time spent on the Alef Platform between the students who started using the platform in 2018 and the students who started using the platform in 2019.

The second question focuses on the teachers’ perceptions of AI-powered digital learning platforms in relation to the students’ performance. The research tries to conclude the teachers’ perceptions on how AI-powered digital learning improves students' learning, increases their engagement, supports their needs, impacts their motivation, helps them discover new content, and enhances their discipline.

The third question covers the impact of the Alef Platform on teachers. The researcher draws a comparison between the usage rate of the platform by the teachers who started using the platform in 2018 and those who started using the platform in 2019. The researcher also collects direct feedback from the teachers on how the platform helps change their role in education and reduce their daily workload.

The fourth and last question investigates the impact of the Alef Platform during the COVID-19 pandemic. The researcher attempts to answer this question by looking into the difference in the students’ and teachers’ usage of the platform and between the number of lessons students complete before and after the pandemic and the resulting closure of the schools. Furthermore, the researcher approaches the teachers for their opinion on the Alef Platform and whether they believe it has supported them amidst the pandemic.

1.4 Background - Alef Education

Alef Education Company was established in 2015 in Abu Dhabi, United Arab Emirates, with one branch in New York, United States of America and another in Amman, Jordan. The company launched the Alef Platform, an AI-powered digital learning platform that has interactive content based on the six core subjects taught in schools, namely, mathematics, science, Arabic language, English language, social studies and Islamic studies, that are aligned with the curriculum of the Ministry of Education in the United Arab Emirates. The Platform is used to teach students in grades 5 to 9 in Abu Dhabi Public Schools and some of the Private Schools across the UAE, in addition to seven schools in New York and one school in Canada.

1.5.1 What Is the Alef Platform

The Alef Platform is an AI-driven interactive digital learning platform that serves students, teachers, and school leaders. At its core, the Alef Platform was originally conceptualized to address the needs of the local public school system in the United Arab Emirates.

The product offers comprehensive, interactive, and immersive content aligned with the six core subjects for grades 5-12 in the UAE and for the subject of mathematics for grades 5-8 in 7 schools across New York, the US. The Alef Platform is used as a primary teaching tool that is specifically designed to engage students. This holistic approach combines an integrated platform with skill-based content digital as well as experiential learning content offline to encourage different types of learning and allow students to develop 21st-century skills. Equally important is that the product registers how a student interacts with the platform, where the Alef Platform tracks how the student interacts with the content, what the student scores in all the formative and summative assessments, the time a student spends on each stage, and the number of lessons a student completes. This allows for extensive data collection, allowing students, teachers, and school leaders to receive live and immediate feedback and data. This not only supports the students, teachers and school leaders with insightful analytics but also feeds into the underlying adaptive learning model of the platform, as explained in Alef's AI Adaptive Learning System mentioned later in the next chapter.

The platform was designed as a primary means of education that includes comprehensive content aligned with the Ministry of Education in the UAE, and it allows for different class-room models; making it possible for a teacher to teach students in a classical manner, a flipped manner, or, given the current situation the world is living today with the COVID-19 pandemic, in a remote manner.

The platform can also be used as a supplementary tool as it is used in schools in the US or for self-directed learning. However, to fully benefit from the advantages of the platform and its analytical data, it should be used on a daily basis.

In the UAE, the content provided on the Alef Platform is completely aligned with the ministerial UAE curriculum for the six core subjects: Arabic Language, English Language, Mathematics, Science, Islamic Studies, and Social Studies. Each subject is divided into micro-lessons that are aligned with the Ministry of Education's pacing guide.

More information on the Alef Platform and the various journeys it includes is mentioned in Appendix (1).

1.5 MOE curriculum

The official national curriculum applied in the public schools in the United Arab Emirates is the curriculum provided by the Ministry of Education, which covers fourteen subjects taught in various grade levels. The curriculum was designed to fulfil the vision and goals of the UAE in Education. It is implemented in all UAE public schools and in the private schools that choose to use the national curriculum. In public schools, all subjects are taught in the Arabic language, with the English language being emphasized. It is a requirement for all schools, whether public or private, to teach the Arabic Language up until grade 12.

The MOE’s subjects are as follows: Arabic Language, English Language, Mathematics, Science, Islamic Studies, Social Studies, Anthropology, Geology, Economics, Geography, History, Psychology, Music and Fine Arts. The first six subjects represent the core subjects, which are included on the Alef Platform (UAE MOE 2020).

1.6 Research Structure

This research includes five main chapters distributed as follows; the first chapter is the Introduction; this chapter provides an overview of the thesis and general information about the methodology that is conducted in this study, the significance of this research, study purpose and objectives. The second chapter covers the background and the theoretical framework of the thesis; the chapter gives an overview of Artificial Intelligence, narrating its history chronologically and showing the main events related to AI in each stage; it also defines artificial intelligence and touches upon the ethical code that companies and individuals should maintain when implementing or using artificial intelligence techniques. The overview of AI also discusses big data, the algorithms used in AI, machine learning, deep learning and the lifecycle of big data in education.

Chapter 2 also covers the conceptual and theoretical frameworks where the main theories of learning are briefly explained. The chapter then moves on to the literature review of the thesis, and it provides the body of the literature that addresses all components of the thesis questions. The literature review starts with the statement and role of AI-powered platforms and continues to provide examples of AI-driven educational platforms from around the world and to discuss the students’ engagement with digital learning, the value AI platforms add to the educational system, the concept of adaptive learning, the roles of both the platform and the teacher in the classroom, the teachers’ practices when using an AI-enabled learning platform and concludes with the impact of COVID-19 on education.

The third chapter explains the research methodology, which shows how the mixed-method approach is used by the researcher to conduct data collection and analysis. The chapter also outlines the research design, the population considered, the sample size of all the participants and their demographic details, data collection instruments, how the collected data is analyzed, the limitations of the study and the ethical processes followed while conducting this study.

The fourth chapter analyzes the quantitative and qualitative data and information collected using the different instruments. It starts with the students' data by analyzing the impact of AI-driven platforms on students' performance and students' engagement with AI-powered learning platforms. The researcher also includes in this chapter the comparison between the two sample groups in performance in the MOE's final exams in the subjects of math, science and English language. Furthermore, the research draws a comparison between the group that started implementing the Alef Platform in 2018 and the group that started in 2019 in many factors, such as the summative assessment scores on the platform and the diagnostic tests results in math, science, language, and reading. The chapter also analyzes the teachers' answers on the impact of the Alef Platform on students' performance. The chapter then moves to the teachers' data and analyzes the teachers' activity on the Alef Platform and the teachers' perceptions towards the Alef Platform. The researcher concludes the quantitative data analysis by analyzing the impact of the digital learning platform during COVID-19. After that, the researcher begins the qualitative data analysis by studying the teachers' perceptions towards the Alef Platform in relation to student learning and engagement, how it enhances class, time and workload management for them, how it supports teachers amidst COVID-19. This chapter also covers the challenges teachers have using the Alef Platform and their recommendations.

The fifth and final chapter discusses the findings of the data analysis results and links the qualitative and quantitative data analysis results with the research questions. The researcher also proposes the recommendation in this chapter based on the thesis findings. The chapter concludes with the contribution of the thesis, where the value this thesis adds to the education literature field is presented along with the study limitations and the further research recommended.

CHAPTER 2:

BACKGROUND, THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.0 Introduction

This chapter consists of four main parts related to the thesis topic, which is How AI-Powered Online Educational Platforms Drive and Improve Student Learning and Teacher Practice in Abu Dhabi Schools. The first section provides an overview of artificial intelligence, starting from the history of AI, the meaning of AI and the main concepts of AI that are related to the thesis, ending with AI applications that support teaching and learning. The second section presents the theoretical and conceptual frameworks. The theoretical framework provides a historical background of education theories and describes the theories that are most pertinent to the topic of the thesis, such as social constructivism and connectivism theories, which are most related to AI-powered digital learning. The chapter then moves to the third section on the instructional core that relates to the thesis topic that has the principles for a successful implementation of digital learning. In the end, the section gives a brief of an adaptive system that provides personalized learning.

The fourth section in this chapter provides previous literature relevant to the main topic of this thesis. The researcher includes previous papers that either supported or argued the thesis and analyze the findings that the previous researchers reached. AI digital learning is a major topic under which many subtopics fall. Extensive previous research has been conducted on these subtopics. The Literature Review section refers to the key findings of these studies and how these studies support this thesis.

2.1 Overview of Artificial intelligence

This section presents a general overview of artificial intelligence (AI) and focuses on some AI concepts and applications in education. The section starts by giving an idea about the history of AI and how the roots of the concept of machine intelligence began even before the 1950s. After that, artificial intelligence is defined, including the period and reason for arriving at artificial intelligence as the name for a machine's intelligence. In addition, this section explains some important concepts of AI which are related to the thesis, such as machine automated learning, deep learning, big data recommendation engine and the lifecycle of big data in education. The purpose of explaining these concepts and how these applications work is to clarify how each of these applications plays its own role in an AI-driven platform to support teaching and learning.

2.1.1 The History of Artificial Intelligence (AI)

Artificial Intelligence has been around for a long time; the section below illustrates the history of AI as divided into several stages where defining developments took place in the AI field.

2.1.1.1 Stage I - Before the 1950s

According to Mijwel (2015), the start of AI can be traced back to the 1200s, when Ebru Al Jezeri invented an automatic machine that can be operated using the force of water. Twenty-three years later, Wilhelm Schickard designed the working system of a calculator that can perform four functions. Later in 1672, a system for counting binary numbers, which are the foundation of our digital world, was invented by Gottfried Leibniz. Charles Babbage, an inventor, and mathematician worked between 1822 - 1859 on developing the first mechanical calculator. In 1923, the idea of a robot (as a human-like machine) was first introduced by Karel Capek in the play R. U. R., which stands for Rossum's Universal Robots. In 1936, the first computer that can be programmed was developed by Konrad Zuse, who called it Z1.

Bearing in mind that robotics is a part of AI, the roots of robots can be tracked to 1942, with the publishing of the Sci-Fi short story "Runaround", authored by American writer Isaac Asimov. The story tells the events of inventing a robot and setting three rules to steer it. These rules are as follows: (1) a robot should not, whether directly or through inaction, cause harm to a human being; (2) a robot should follow whatever orders a human gives it, except the cases where such order(s) are not in accordance with the first law; and (3) a robot must always protect itself given that this doesn't conflict with the First or Second Laws. In some way or another, this story left a great influence over American Scientist Marvin Minsky, who later grew to play a huge role in AI and the establishment of MIT laboratory for AI". (Haenlein & Kaplan 2019)

Stage one ended in 1946 when the first functioning computer was successfully built. However, the size of this computer was so huge it took a full-space room and weighed 30 tons.

2.1.1.2 Stage II - The Rise of AI

Researchers argue that the real start of AI was in 1950 when Dr Alan M. Turing published his article "Computing Machinery and Intelligence" (Casarella 2011, Turing 1950). Dr Turing started his article with the question, "Can machines think?". To answer this question, Dr Turing suggested an altered version of the well-known game called The Imitation Game. In this game, three individuals, the inquirer, the male and the female, are put in three different rooms. The only means of communication between the inquirer and the other two are made through a "teletype" (Turing 1950). The challenge in the game is as follows: the male pretends to be a female in his answers, while the female gives honest answers. The inquirer has to guess who the male is and who the female is based on their answers. So, the logic here is that the inquirer is physically obscured from seeing the person who is providing the answer. To help lay the groundwork for thinking machines, Dr Turing adjusted this game so that the inquirer receives two answers: one from a human and the other from a machine. If the inquirer fails to detect which answer is received from the machine and which is not, the machine passes the test. This later came to be known as the "Turing Test" (Turing 1950, Casarella 2011).

Dr Turing believed that what needs to be done to achieve this goal is to learn how to program a machine into copying our brains (Turing 1950, Casarella 2011).

2.1.1.3 Stage III - The Golden Age of AI

Six years after the Turing test, a group of scientists, including the Computer Scientist John McCarthy, got together and put a proposal to study artificial intelligence. The group agreed that they would base their study on the principle that it is possible to minutely describe each and every aspect of learning and intelligence so that it can be simulated in a machine (McCarthy 1955). The highlight of this conference was that two opposing approaches were submitted to tackle the study: the top-down approach and the bottom-up approach.

The bottom-up approach stipulated that the machine is fed with primary data by way of training until it learns how to classify an output based on the input (Wooldridge 2018). However, a top-down approach means that the system of the machine is already programmed with the necessary knowledge and that it utilizes this knowledge to produce an output. After much debate, the top-down approach, designed by Professor Marvin Minsky, won the battle. Professor Minsky took AI to the next level when he raised the issues that needed to be solved in relation to the neural network in his book “Perceptrons” (Rich, Knight & B Nair 2017).

Since then, AI took a slower turn for a few years, where minor achievements succeeded. In the late 1950s, Margaret Masterman, with the help of other scientists, developed the first network for machine translation (Mijwel 2015). John McCarthy continued his work in the field, and by 1958, he created the LISP Language (List Processing Language).

In 1960, American psychologist JCR Licklider discussed the relationship between humans and machines in his work. Two years later, the first company to manufacture robots to perform industrial work was established under the name “Unimation” (Mijwel 2015).

Turing’s work started to pay off in 1964 when Joseph Weizenbaum created the computer program “ELIZA” - a machine that is capable of processing natural language and simulating a conversation with humans. It is the type of machine that could possibly pass the Turing test mentioned earlier (Haenlein & Kaplan 2019).

At Stanford University in 1966, the first robot that could move around without continuous control by a human factor was Shakey the Robot. Shakey was able to detect the objects placed in its way and was able to successfully avoid them (SRI International 2019)

2.1.1.4 Stage IV: AI Winter

The years from 1973 to 1980 later came to be known as “The Winter Age of AI” (Wooldridge 2018). The simile is made as in similarity to the activity of humans in this season, where we tend to stay home and be less active. Despite that, there were some highlights that could be contracted to the development of AI. According to Mijwel (2015), the Defense Advanced Research Projects

Agency in the United States (DARPA) developed the protocols “TCIP / IP”. The following year, 1974, marked the beginning of the usage of the internet.

During the AI Winter Age, the argument of the Chinese Room started (Searle 1980). In 1980, American philosopher John Searle, in response to the Turing Test, which he described as “Strong AI”, presented a scenario that proves the Turing Test ineffective. This means that even if a machine passes the Turing Test, this doesn’t necessarily prove 100% that machines are intelligent. The story goes as follows: Imagine that you are a person who speaks English as their native language and that you don’t understand any word of Chinese. You are then locked in a room with just a book of rules and symbols. Just outside the room, there’s a Chinese speaking person who slips you a piece of paper with a question written on it, but it is in Chinese. The Chinese person outside the room doesn’t know that you do not speak Chinese. Your role here is to find those Chinese words/letters and answer them as per the rule book. After some time, you end up with the answer exactly, as shown in the rule book, not knowing or understanding any of what is written there whatsoever. The Chinese person then gets the answer written on a piece of paper in Chinese, and logic dictates that they would believe that you speak perfect Chinese. Searle wants you to imagine here that: you are playing the role of a computer (or a machine), the Chinese person is the outside interactive factor (or mainly humans), the rule book is the program, and the questions are the database fed into the computer. Searle’s argument is that even if we reach an ideal level of programming the machine into simulating our human brain, it will never succeed in thinking intelligently and for itself because what a machine has is merely symbols and rules, while our brains have meaning in addition to that, (Searle 1980).

2.1.1.5 Stage V: The New Era of AI

In 1984, a project named CYC was born, an experiment that is still ongoing until these days (Wooldridge 2018). The CYC project is aimed at creating a machine that can act based on common sense. The computer reaches the stage of common sense after having been fed huge amounts of facts and other types of information that make it ultimately capable of processing natural language (Wooldridge 2018).

In 1997, a renowned chess player was challenged to a chess game with Deep Blue, a supercomputer developed by IBM. The game ended with the victory of Deep Blue (Mijwel, 2015). A year later, the first Furbytoy was released - a toy that could talk to kids manifest a number of actions upon acting to it in a specific way (Mijwel 2015).

2.1.1.6 Stage VI: Post-Millennium AI

In 2010, a breakthrough was made in AI when Apple introduced the world to Siri - a speech-recognition technology that can be incorporated into mobile phones (Bosker 2013).

According to Haenlein & Kaplan (2019), most of the applications and tools that we recognize as AI are built on the study of neural networks and deep learning, which helped image and voice recognition technologies come to life. Such technologies are being increasingly incorporated into all aspects of life, be it security, medicine, entertainment, customer service, etc. (Parloff 2016) believes that due to the huge development of AI research, it has become known that all that is needed is for the machine to be thoroughly trained with as much data as possible for it to be able to perform the tasks it was programmed to do in an impeccable manner.

Machines have also, in some cases, outperformed humans due to their little to zero level of error. This has become more possible than before due to the fact that companies that are looking to integrate AI in their system are now more able to access data, which is what the machine needs most (Parloff 2016).

2.1.2 What is Artificial Intelligence?

The Oxford dictionary defines artificial as something “made or produced by human beings rather than occurring naturally, especially as a copy of something natural" (Oxford Dictionary 2020). According to Cambridge Dictionary, intelligence is “the ability to learn, understand, and make judgments or have opinions that are based on reason” (Oxford Dictionary 2020).

Artificial Intelligence is “[something created by humans] that has the ability to [use reason to receive information and act upon them]”. According to Phrommaphan, Mutchimadilok & Tangkraingkij (2018), Artificial Intelligence encompasses and collides with several sectors of knowledge, including science, technology, computer science, biology, psychology, linguistics, mathematics, and engineering. Put together; these sciences are used to design a computer or a machine with the ability to speak, hear, listen, see, walk, think and feel the same way humans do. AI is also defined as the study that aims at building a machine that emulates the individuality of the human mind. Murphy (2019) presented artificial intelligence as software algorithms applied in a way that makes a machine simulate how humans think and make decisions so that they can accomplish tasks. Gauglitz (2019, P.1) presented AI in his research as a “new field in computer science, natural language processing (NLP) and neural networks.” Gauglitz indicated that AI is essentially enabling the machine to take a rational action and ultimately attain the desired goals. In other words, and as suggested by Schere (2016, P.361), AI represents the computational arm that can achieve goals in the world; therefore, machines are now capable of doing the work that in the past only humans were capable of doing because it required intelligence to be successfully completed, (Scherer 2016, P.361). However, for the machine to be able to achieve the required goals, it first needs to be fed with huge amounts of data and information to be trained to mimic the real world and act like humans, Ahmed Habeeb (2017).

In their paper titled “Artificial Intelligence: A Modern Approach”, Russell and Norvig (2016) argue that it is not possible to limit AI in one definition. In an attempt to arrive at a comprehensive definition of AI, Russel and Norvig ended up with a range of eight definitions for artificial intelligence that can be grouped into four categories: “thinking humanly, acting humanly, thinking rationally and acting rationally.” (P.1).

Thinking Humanly

Thinking humanly is defined by the machine’s ability to utterly think like a human. This means that the machine is fully capable of processing thoughts, making decisions, and solving problems the way a human does. If this was ever to be achieved, Russel and Norvig believe that we will eventually be able to comprehend how we humans think (Russell and Norvig 2016).

Thinking Rationally

Rationally here refers to a mechanical thought process where a decision or an action is based on receiving input, judging it, and then acting on it. In an ideal situation, the machine uses logic to process data and takes actionable decisions (Russell and Norvig 2016).

Acting Humanly

In an earlier section in this paper, the researcher tells the story of the Turing Test, where a machine takes a test that is normally performed by humans. Acting humanly is when a machine passes such a test because it needs to act as a human to be considered intelligent.

Acting Rationally

In this category, a machine is defined by its ability to make the best out of the current situation or the best that could be expected out of the machine (Russell and Norvig 2016).

According to Ergen (2019), intelligence is what makes humans extraordinary to other creatures. Despite the huge progress made in AI, we don’t know yet to what extent the intelligence of a machine can reach. Ergen argues that there are two levels of intelligence: the first one includes the abilities to speak and transfer knowledge, and the second is the ability to go beyond this by making conclusions based on logic, being able to adjust to the surrounding situation, and more than anything else, learning. Looking at ourselves, we realize that our actions are based on what we have experienced and observed in addition to what we are taught. There are so many different and creative ways to do anything because each and every individual act differently according to their own perspective. Therefore, finding a pattern to the human mind and behaviour that can be integrated into the machine is not a simple matter. To find this pattern, we need data - loads and loads of it. The machine needs to be fed with huge amounts of data - commonly recognized as big data - to be able to comprehend and learn how to act like a human (Ergen 2019).

2. 1.3 The Ethics of Artificial Intelligence

Similar to any new innovation and technological development, when AI and the idea of AI came to the surface, some people were impressed and wanted to work further to achieve it, and others were sceptical of the impact and the negative side of it that the world could be oblivious to. One of the major issues that were pointed out many times over is related to the ethics and legality of AI applications. According to Hao (2018), although AI has been around for a while now, there is still no definite and universally accepted framework that defines the legal and ethical limits to AI and the authority that is supposed to make sure these limits are not crossed.

One of the suggestions proposed by a panel of experts who worked on the report "One Hundred Year Study on Artificial Intelligence" to help solve the ethical issues that have been raised with regards to applying AI is collecting more experience and learn more about the technicalities of artificial intelligence as well as for governments to put in place official policies on implementing AI and dedicate more financial and human resources to ensure that the privacy and security of the individuals are guaranteed, (Stanford University 2016).

However, any organization or entity looking to implement AI should put more focus on three areas of AI application.

2.1.3.1 Privacy

Wehmeier (2005) explains privacy as the fact that one is not disturbed and is not exposed to public attention. With the advent of information technology, it has become increasingly difficult to protect one's privacy against retaining, modifying, and exchanging personal information without the person's permission (Deame 2018).

AI essentially runs on data, meaning that for any system to be powered by AI, it has to collect data - personal data. Therefore, any AI-adopting organization must make sure that despite the fact that data is being collected, it should be protected as per universal human rights (Hao 2018). There are “impacts assessments” that have been put in place for organizations to test the impact of their AI applications on the individuals they deal with (Latonero 2018).

Latonero (2018) also suggests that recently, new techniques have been developed to ensure individuals’ privacy is protected during the design process of the product or technology. This means that while the product or technology is being built, tests and measurements are taken to study the possible implications of AI with regards to the privacy factor to help counter such threats from the beginning. This method is known as the “privacy by design” approach, and it includes conducting an “impact assessment” to define the possible privacy concerns and risks that may arise in the future. According to Meyer (2018), major players in the market seek the protection of the privacy of the consumers to gain their trust in their products and services. Some of these companies pushed to enact legislation that ensures personal data is protected.

2.1.3.2 Replication

Replication is defined as the inability to identify the cause of an incorrect decision made by the machine. When we are able to replicate something, we can completely dissect the process that led to the final result or decision. One of the issues humans face with AI so far is that we cannot identify how the machine (or, to be more specific, the neural network of the machine) arrived at a specific “incorrect decision” (Nogrady 2016).

Companies and major industries now largely depend on AI in their dealings with customers. Relying on AI to make a decision means that the company is held accountable for this decision. So, when a customer demands an explanation of a decision/recommendation (that was made by AI), the company would simply have no answer. Although this seems unlikely to happen in the near future, the problem does not go away by achieving this. When the inner workings of a company's AI system are revealed, other confidential information is too. This could potentially pose a threat to the future of the company and its IP. The companies' right not to reveal such data could be regulated and protected by the General Data Protection Regulation in case it has value to it (European Union 2016).

2.1.3.3 Bias

The Oxford Dictionary defines bias as "inclination or prejudice **for** or **against** one person or group, especially in a way considered to be unfair." Is it possible for a machine to be biased?

According to Heshmat (2015), one of the most common types of bias in AI is confirmation bias. In general, it means that the subject pays more heed to the facts or evidence that agree with their beliefs than the ones that oppose it. So, in our search for a result, once we reach what we believe in, we stop looking, and we consider that to be the end of the task well done.

A common term to describe bias in the algorithms of an AI system is "algorithmic bias". This usually occurs when the data that is the machine or the AI system is fed is originally biased, whether from a political, racial or gender or any other perspective. As discussed previously, AI runs on the data it is fed, and when this data is biased, it is only logical that the result is (Eder 2018).

According to Byrne (2018), if a decision or a recommendation made by AI has an effect on people, it is very important that the algorithms and data fed to the AI system are unbiased. With the prevalence of AI in almost all industries, it has become a necessity to identify, explain and put an end to algorithmic bias (Dickson 2018).

As a solution, (Eder 2018) proposes that companies assign "ethicists" to study the AI system before allowing it to make decisions. To try to avoid feeding the system wrongful algorithms, companies need to impose a very strict protocol that makes sure the data entered is not biased. Bias is thought to be correlated with replication (or explain-ability). According to Byrne (2018), programmers need to understand and identify how the AI system reaches a decision for them to be able to identify where bias occurs.

The rate of the risk of bias varies between one sector, and another, the riskiest of all is the healthcare sector. To help avoid any risk befalling any individual, more work has to be done in order to tackle bias. As the researcher mentioned above, the data collected should essentially be unbiased because the results are based on this data. Moreover, similar to humans, machines need to be kept updated. Relying on the same model of training won't help the machine develop its decision-making process.

Byrne (2018) suggests that there's a difference between what is ethical and what is legal. Technically, not every unethical action or behaviour is considered illegal and actionable by law. Therefore, companies should go out of their way and put together internal policies that ensure ethnicity is observed. AI has and continues to help humanity progress further ahead, but we need to work together to make sure we do not fall or cause others to fall victims to its risks (Bossman 2016).

To better understand how the system of AI works and, in an attempt, to try to learn how it makes a decision, it is important to study the behaviour of AI and the most intrinsic component of AI, namely, the neural network.

2.1.4 The Key Concepts of Artificial Intelligence

Karsenti (2019) defines AI as the arm of computer sciences that involves designing intelligent machines to perform tasks that usually require human intelligence. Such machines are capable of processing data and predict the trends present in the data the machine is fed to make intelligent predictions. Thus far, AI has helped mainly by automating the routine and time-consuming tasks, which would require the efforts of groups of human beings to perform. Artificial intelligence has also offered huge opportunities in the education sector, as elaborated below:

2.1.4.1 Big Data

In a report published by McKinsey Institute for Global Data Analysis, Big Data is as data sets that are larger than what typical database software tools can collect, store, manage and analyze, (Karsenti 2019).

Karsenti (2019) makes a connection between big data and artificial intelligence by defining big data as a fully digital environment that encompasses a large number of data sets, while AI is what takes care of these huge data sets. AI creates algorithms that detect the trends and patterns in the aforementioned data sets and process them to make predictions.

As (Xianzhen 2019) suggests, the difference between big and traditional data is best manifested in the education sector. While traditional data point towards the overall and general outcome of the student's performance, big data digs much deeper into the learning behaviour and collects the slighted and what could be considered insignificant data to try and find a pattern that can lead to a result or observation. Such observations can influence the teaching approach and eventually improve student learning.

2.1.4.2 Algorithms

According to Karsenti (2019), algorithms are considered to be the regulators in the field of artificial intelligence; what they do is instruct the program or the machine how to act upon the data it is fed and make predictions based on it. Through algorithms, humans can speak to the machines and software and ask them to perform a set of actions, such as recognizing faces and voices.

2.1.4.3 Machine / Automated Learning

As per Karensite (2019), as a way to enable machines and programs to produce the required results or tasks, humans can use, develop, and manipulate algorithms to reach the desired outcomes. Within the context of educational platforms, algorithms are more than a mere direct rule of a cause and effect. Rather, machines and platforms are now trained to act and provide personalized support based on the received data.

According to Russell and Norvig (2016), For a machine to be considered intelligent, it has to possess the ability to perform the below:

- Processing natural language so that the machine can communicate with humans without us figuring out it is a machine
- Storing data and information and being able to come back to this storage and take out what is needed for the current situation.

- Logical mechanism where the machine makes conclusions based on the input.
- Machine learning: where a machine is able to learn based on the history and data fed into it and take novel actions based on that knowledge (Russell & Norvig 2016).

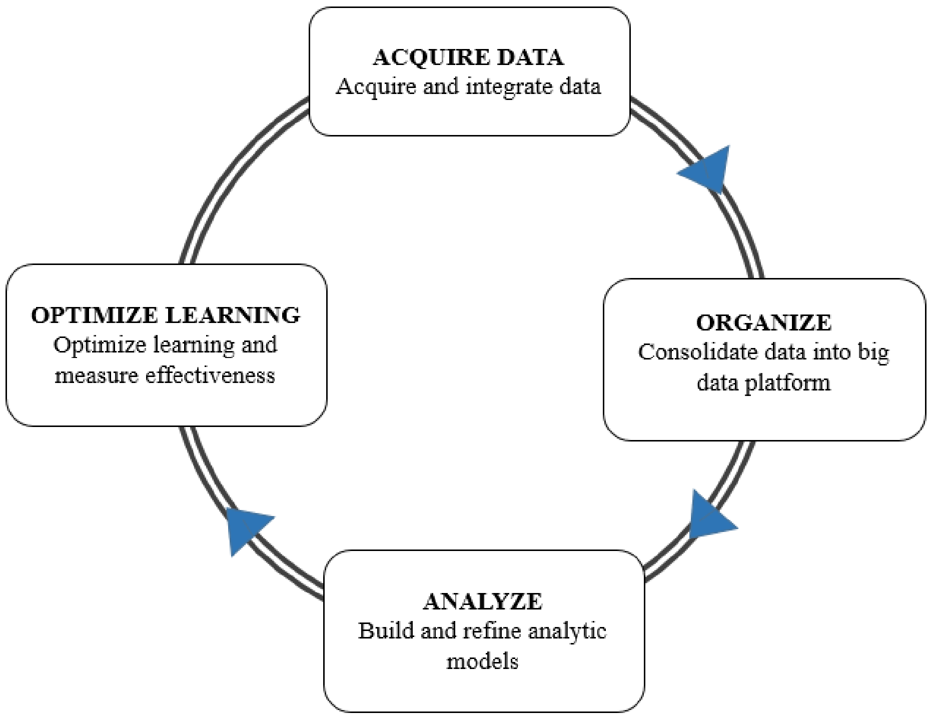
2.1.4.4 Deep Learning

Karensite (2019) describes deep learning as the architecture of the machine's brain, which, similar to the human brain, is a complex and stratified network of neurons. In deep learning, data is not interpreted and read as standalone and separate units but rather as layers of intricately connected data. For example, in facial and image recognition, the image is first processed as a set of features, and each feature is then processed and interpreted according to a set of inputs that are compared against the big data that the machine was trained on. After this stage, each input is given a certain weight according to how relevant and accurate it is, ultimately coming up with a prediction of the image content.

2. 1.5 The Lifecycle of Big Data in Education

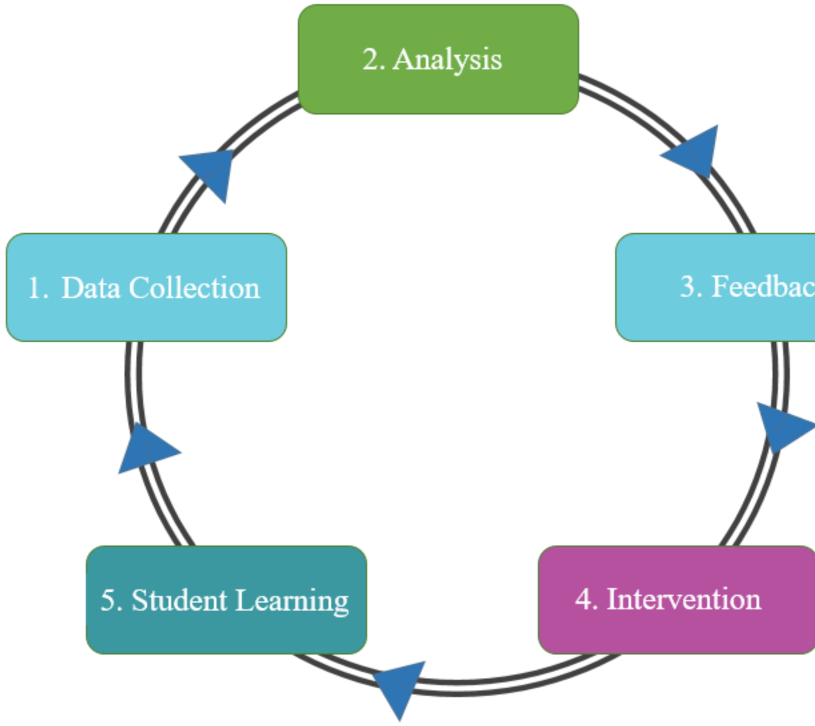
Figure 2.1 shows the lifecycle of Big Data. There is not much of a difference from the method of collecting traditional data. However, the big data that is being collected in platforms is more efficient and, most importantly, comprehensive and highly detailed. For example, throughout the learning process and whenever the student is logged into the platform, the data collected captures and records the learner's behaviour, including but not limited to: the time spent on each section and page, the regularity of assignment submission and even the clicks made on any place on the platform, (Xi, Chen & Wang 2018). This data is what helps platforms deliver more personalized content to the learner. This personalized content is delivered to students based on factors such as the time they spend on the pages of the platform, which is run to classify learners based on their level.

Figure 2.1 The lifecycle of big data generated from MOOCs (Xi, Chen & Wang 2018)



As illustrated in Figure 2.2, the lifecycle of big data in adaptive learning follows four basic steps: starting with collecting primary data while the student is learning, analyzing the primary data that is collected, recommending feedback based on the results of the analysis, and ending with teacher and parents' intervention, and so on. The last phase is the most important of all as this can make sure the student learning improves, which results in new primary data being collected and new feedback being recommended (Xianzhen 2019)

Figure 2.2 Preliminary Model of learning analysis system (Xianzhen 2019, P 203)



2.1.6 Building a Recommendation System

According to Ergen (2019), most AI applications today are seen as machine learning. What a machine does is basically take in the data it is fed, analyze it and come up with a pattern. The more data the machine is fed, the more it learns, and the better predictions it comes up with. This process starts by training the machine with fake but logical data to teach the machine the criteria to follow moving forward.

After a machine is trained with fake data, and once it is fed new data, the machine, according to Mcleod (2018), starts generating values and results that are based on the training it previously received. As machines are trained with data that humans input in them, it is possible that this data, if it went unnoticed, can be biased or discriminatory, hence, resulting in biased values and results. Therefore, (Mcleod 2018) suggests training machines using diverse data that includes all races and cultures, sexual orientations, identities, religions, ages, etc., to avoid unfair decisions or negative impact.

2.2 Theoretical and Conceptual Framework

This section discusses the theoretical and conceptual framework; it goes through the theoretical framework starting from the first theories about learning with a deep explanation of constructivism and connectivism theories which are more related to digital learning. Then it presents the instructional work as a conceptual framework related to the thesis, which considers three main elements in education, which are teacher, student and content; the improvement of any elements should consider the other two. Lastly, the researcher gives a brief overview of the adaptive learning system framework.

When educators want to adapt to a new learning style, they must be based on learning theories (Goldie 2016). The first computer system for education was built based on behaviourist learning theory, which suggests that “learning is a change in observable behaviour caused by external stimuli in the environment” (Anderson 2008, p.18). No matter if learners learned something or not, and no matter what was happening in their heads, the system led educators to shift to cognitive theories (Anderson 2008). Cognitive learning theories claim that “learning involves the use of memory, motivation, and thinking” (Anderson 2008, p.19), and their claim refers to the learning of the internal process in learners and the amount of learning based on learner’s effort, attempt and handling capacity (Anderson 2008). According to Mayer (2001), the cognitive theory has three assumptions for multimedia learning: dual channels (learners have different channels to process different learning materials such as visual and audio), limited capacity (the amount of knowledge that learners can process in every channel is limited), and active processing (active learning enhances people engagement).

In this section, the researcher illustrates the main relevant and latest learning theories: constructivism theory and connectivism theory; and explains how these theories could link to digital learning and guide digital learning designers to provide quality digital content. These theories present learning principles based on learning needs as well as the principles driven from these theories to support digital and digital learning.

The aim of any education system, including digital systems, digital learning, or E-learning, is to enhance learning. To do so, the developer of digital and digital learning materials has to understand the principles of learning, and they should understand how the learning process happened and how learners learn. They must be aware of fundamental learning theories if they want their materials to be effective (Anderson 2008). According to Anderson (2008), there is no school of thought that provides exclusive design for any digital learning material, so educators can't follow any single theory, but they use "a combination of theories" to provide digital materials (Anderson 2008, p.18). Siemens (2005) claims that these learning theories lack understanding about the learning happening outside learners, such as learning operated by technology and comes from outside learners through media or network. It also cannot explain the process of learning inside organizations.

2.2.1 Constructivism Theory

Educators then moved to Constructivist theorists, who was created by John Dewey and Jean Piaget. According to Anderson (2008), in the constructivist approach, learners "interpret the information and the world according to their personal reality. They learn by observation, processing, and interpretation, and then they personalize the information into personal knowledge” (p.19). When students apply directly what they learn and contextualize it, they learn better. According to Anderson (2016), Constructivist theory developed a guideline for designers to help them provide an effective learning design to support and promote learners’ engagement (both as students and teachers) to be considered as a “critically important” component for learning (Anderson 2016 p. 54).

Social Constructivism Foundations

Piaget believed that real-life experiences should be the focus of educators when they guide student's learning, and therefore must work on building knowledge of the learner by applying inquiry-based questions. This helps guide students to start to think and build their knowledge. Constructivism theory focuses on metacognition and how learners create their thoughts or notions, as well as the process of how learners build and create knowledge. Therefore, it disagrees with behaviourism theory as the latter emphasizes the repetition and memorization of the information as a way of learning (Mucundanyi 2019).

According to Mucundanyi (2019), social constructivism focuses on three components: “reality, knowledge, and learning”. The reality occurs within the social interaction, so it is structured so that when people interact with each other, knowledge is generated by the interaction taking place between people and their environments. That is why this theory is considered a social and cultural product where learning requires engagement from learners with social activities; hence, learning is considered a social process. Therefore, teachers become facilitators, and their role is to encourage students to gain knowledge by creating a social environment that helps them to engage with what they are learning (Mucundanyi 2019).

Based on constructivism, some researchers, such as Wheatley, Yager, and Tam, created general principles to help teachers apply this theory in their classrooms. These principles became very valuable, not just for teachers but also for digital learning systems or platforms designers (Mucundanyi 2019). Below are these principles, as mentioned in (Mucundanyi 2019):

1. Give more focus to learning, not performance: teaching and learning should give attention to building students' knowledge and skills. Exams or tests cannot be the only basis for learning. Usually, exams put both students and their teachers under pressure. Also, exam results may not reflect the reality in learning, and they rather depend on the environment within which the exam was taken as well as the situation of the student at the time of taking the exam. So, the teacher should guide students to build their knowledge and skills to be able to understand and deal with the real world (Mucundanyi 2019).

2. Learners are contributors to knowledge and not just receptors of it: With social constructivism, the teacher is no longer considered the centre of the educational process in the classroom. On the contrary, the student becomes the centre of the educational process; as in this theory, the learners become involved in building knowledge, and they act as knowledge makers. The students contribute to discovering and building new knowledge and sharing it with others so that co-construction is given meaning. Students should not fear making errors or mistakes, and they should understand that failing and making such mistakes is necessary to learn and build new knowledge (Mucundanyi 2019).

3. Teachers should guide students, not just instruct them: Teachers should seek to build a strong relationship with their students, where teachers play the role of guiders and supporters and not just instructors (Mucundanyi 2019).

4. Teachers should create an environment that helps students to engage with the learning material through doing some tasks that relate to their real individual lives and by participating in group work where students learn from each other and gain teamwork and communication skills that help increase their opportunity to succeed in making a career. Students should also be able to do self or peer assessment and review (Mucundanyi 2019).

5. The main purpose of assessment activities should be to expand the opportunities of students' learning. Therefore, it should be made sure that students grasp learning during the assessment process (Mucundanyi 2019).

The social constructivist principles are vital for both normal classroom and digital sections; therefore, it is very important that designers of digital courses and platforms understand these principles and put them into their consideration.

2.2.2 Connectivism Theory

According to Shrivastava (2018), the Connectivism theory, created by George Siemens and Stephen Downes, denounces the boundaries set by the three theories mentioned above to support digital learning. Connectivism Theory is "the thesis that knowledge is distributed across a network of connections, and therefore that learning consists of the ability to construct and traverse those networks" (Khatibi & Fouladchang 2015, p.83)

In 2005, Downes and Siemens developed connectivism theory to serve the digital age and to meet e-learning and network learning requirements. The purpose of connectivism theory is to create an instrument that enables educators to understand better and manage teaching and learning while implementing digital learning (Rubens, Kaplan & Okamoto 2011; Goldie 2016). Connectivism theory provides a conceptual framework that pretends students as a network phenomenon, and they are influenced by socialization and network technology throughout their learning path using digital learning (Rubens, Kaplan & Okamoto 2011; Goldie 2016).

Based on connectivism theory, learners start to learn and gain knowledge when they come into contact with the learning community and bargain to participate in this community (Rubens, Kaplan & Okamoto 2011; Goldie 2016). The definition of learning communities is "the clustering of similar areas of interest that allows for interaction, sharing, dialoguing and thinking together" (Goldie 2016 p.5).

Learning happens when learners communicate with each other, especially the learning community, which usually has learners from different levels of knowledge and skills. When the communication happens through the network /media, this communication includes visual learning material such as videos, audios and images, which enable students to create their own learning environment and also help educators and providers to produce tech learning resources (Khatibi & Fouladchang 2015; Goldie 2016).

In connectivism theory, Goldie (2016) believes that the network is made of several learning communities, and each learning community is considered a node. When interaction and connection between two or more nodes happen, the network emerges (Khatibi & Fouladchang 2015). Hence, a node is considered as a part of a big network. In the same way, each digital library, digital platform, journal, digital university or school and digital organization is considered a node of a bigger learning network community (Khatibi & Fouladchang 2015). The strength and size of these networks differ depending on the number of learners, viewers, size of the resources and the strength of the data that each network has (Khatibi & Fouladchang 2015; Goldie 2016).

According to Goldie (2016), researchers believe that connectivism solves the challenges that can be faced with the dissemination of knowledge data by connecting this data with the people who have the ability to analyze this data and link it to the right content to achieve learning. Goldie (2016, p.4) illustrate eight principles of Connectivism theory as listed below:

- Learning and knowledge rest in diversity of opinions.
- Learning is a process of connecting specialized nodes or information sources.
- Learning may reside in non-human appliances.
- The capacity to know more is more critical than what is currently known.
- Nurturing and maintaining connections is needed to facilitate continual learning.
- Ability to see connections between fields, ideas, and concepts is a core skill.
- Accuracy (accurate, up-to-date knowledge) is the intent of all connectivism learning activities.
- Decision-making is itself a learning process. Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality. While there is a right answer now, it may be wrong tomorrow due to alterations in the information climate affecting the decision. (Goldie 2016, p.4).

According to Herlo (2017), connectivism theory, similar to any other new theories, was exposed to some criticism from educators. This makes educators not depend on connectivism theory to address all of the education issues as a standalone theory. However, many of its principles can be drawn from learning theories that preceded it such as, behaviourism, cognitivism, constructivism and social constructivism theories.

Herlo (2017) believes that despite the huge strides of development made in artificial intelligence and machine learning, connectivism theory does not give an illustration as to how machines learn; the theory lacks the understanding of the concept of machine learning. Moreover, the theory does not show how exactly the machine is able to recognize a pattern in the data it is fed, a factor that gives the machine the recognition ability (Herlo 2017). To clarify, the interaction between the different learning nodes within the network is stated in a very simple way. Siemens, the founder of Connectivism Theory, also focused on the epistemology of the individual humans in his theory and did not cover how non-humans, or more specifically, machines, acquire the knowledge (Rubens, Kaplan & Okamoto 2011; Goldie 2016; Herlo 2017). Another main criticism that was pointed out by several theorists is that Connectivism Theory has not been practically tested to reach a conclusive proof of concept.

Even though Connectivism Theory has some limitations, it is believed that the theory gives an insightful understanding of the process of learning taking place in a digital learning environment and between the different learning communities that constitute our nowadays lives. The theory has been mentioned in many works of literature in the education field and has also been listed as a learning theory in a learning theory aggregator Godie (2016).

According to Ertmer & Newby (2013), digital and digital learning lessons must be based on principles from all learning theories; behaviourism, cognitive and constructivist, connectivism and social constructivism, for example, teaching facts by using behaviourist approach, teaching the process by using the cognitive approach and teaching high-order thinking by using the constructivist approach to enhance students learning put them in a learning community where they can learn from each other and abundant sources in the learning network community.

Anderson (2008) presents some principles driven from all of these theories and explains how to apply these theories in digital and digital learning as below:

- Online digital learning lessons that adopt AI should have clear objectives and expectations for learners so they can have full pictures about what they need to achieve from that lesson or materials lesson. Learners must be aware of learning outcomes and the expectations of them (Nokelainen 2006; Anderson 2008).
- AI in digital lessons should provide many types of assessments that computers can mark, provide views of what the students truly understand, and provide direct and appropriate feedback for students about their achievement (Nokelainen 2006; Anderson 2008; Herlo 2017).
- Progressive and consecutive must be a characteristic of digital learning material (Nokelainen 2006; Herlo 2017).
- AI in digital learning must provide a tool for monitoring learners in order to provide corrective intervention, if necessary (Anderson 2008; Herlo 2017).
- AI-adopting digital lessons should have a strategy to help students perceive information and also should have the strategy to maximize student sensation through using different colours, good text size, and different modes, such as video, audio, animation and virtual reality in their lessons and materials (Jung & Lee 2018; Anderson 2008).
- Online digital learning strategies help students use long-term memory information and link it to new relative information (Jung & Lee 2018; Anderson 2008).

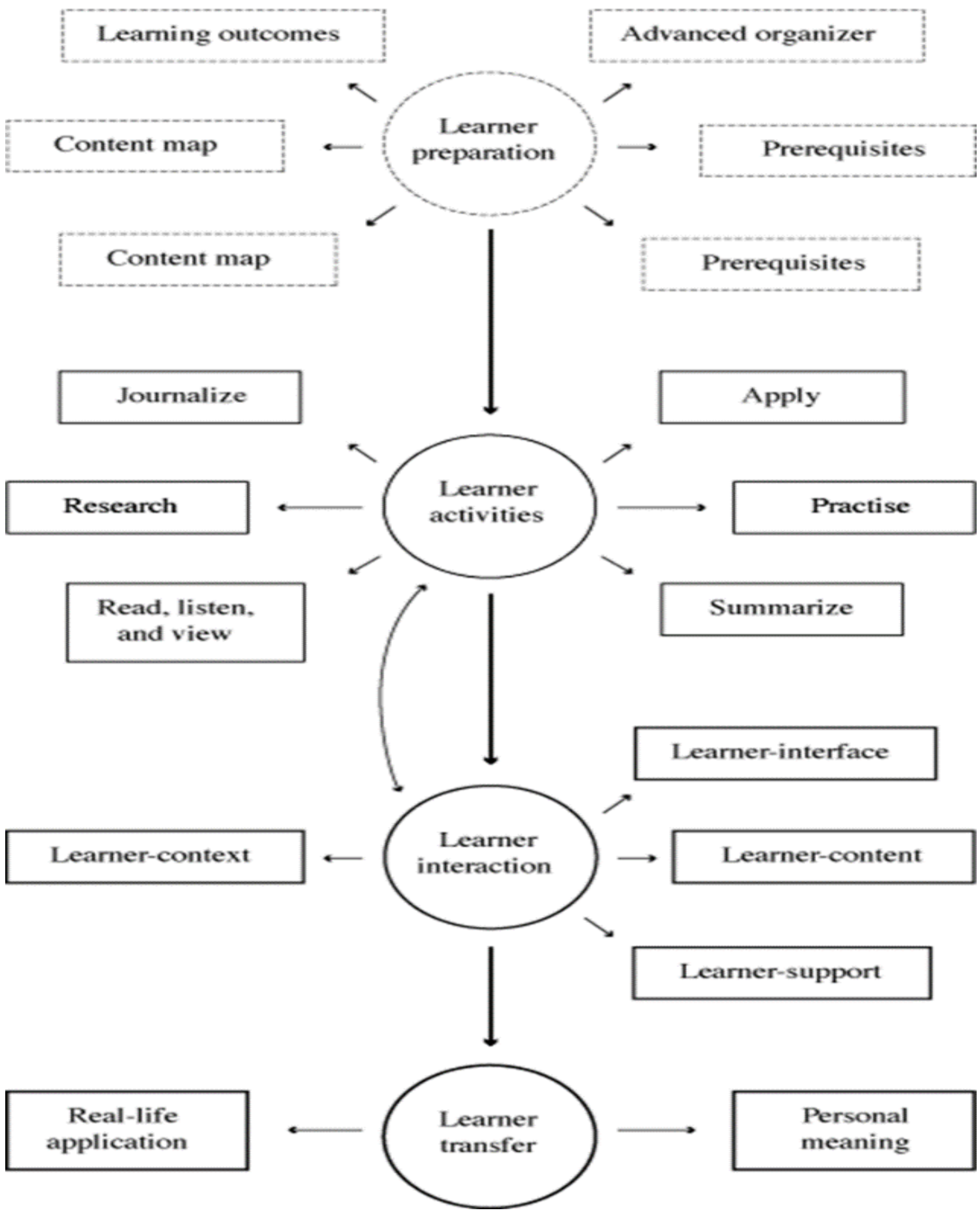
- Online digital learning material should be organized in the best ways to help students to organize and save information in their short-term and long-term memories so digital learning lessons should map information using hierarchy maps, linear representation, or spider maps as a chunk of information (Anderson 2008).
- Online digital learning materials should have strategies to make students apply what they study to their life, which in turn supports the transfer of knowledge to long-term memory through passing in deep processing (Rubens, Kaplan & Okamoto 2011; Anderson 2008).
- Online digital learning lessons should accommodate different styles and levels of learning for students (Anderson 2008).
- Online digital learning material must be designed to motivate students to learn through using intrinsic and extrinsic motivation, capturing students' attention, using relevant information to their life and benefits, building students confidence through design lessons for students' success, and providing satisfactory feedback which helps students to improve and attain some progress (Anderson 2008; Herlo 2017).
- Online digital learning materials should, through using the technology of AI, provide an opportunity for students to make self-reflecting and self-evaluation about what they learned and their improvement by collaborating with classmates, which helps them to gain metacognitive skills (Anderson 2008).
- Online digital learning activities should be meaningful, personalized, and individualized for learners so that they keep students active and practising in a high-level process (Rubens, Kaplan & Okamoto 2011; Anderson 2008).

- Online digital learning should build interactive materials that facilitate and help students to construct, create and build their knowledge which supports students to have initiatives toward learning (Hernández-García et al. 2015; Anderson 2008).
- Online digital learning activities should fully support and encourage cooperative learning, which provides a real-life experience of teamwork and gives students the ability to help each other and get benefits from using each other's strengths and also help them improve their metacognitive skills (Hernández-García et al. 2015; Anderson 2008).
- Students should have control over the learning procedure and method, and they should be able to make a decision about their learning goals (Anderson 2008).
- Online digital learning should provide opportunities and time for learners to reflect and adopt the information and knowledge they learned. Digital learning designers should embed some questions or activities through the lesson that supports reflecting and implements the information in a good way, such as creating a journal or writing a story (Hernández-García et al. 2015; Anderson 2008).
- Online digital learning should support learners to provide new knowledge and skills; students should interact with knowledge and their environment and promote a meaningful and responsible sense of their community (Rubens, Kaplan & Okamoto 2011; Anderson 2008).

Based on these principles, Anderson (2008) proposed a model which presents the significant learning components based on learning theories and should be recognized by digital learning designers. Figure 2.3 below illustrates these key components, which Anderson (2008) considered as the significant keys for digital learning that designers should focus on. The current thesis is about AI-powered platforms and how they impact students' learning and teachers' practice. These

AI-enabled platforms require digital content as the main driver of the educational process. The whole learning process is digital learning; hence, designers of digital content should consider these significant keys to digital learning.

Figure 2.3 Components of effective digital learning (Anderson 2008)

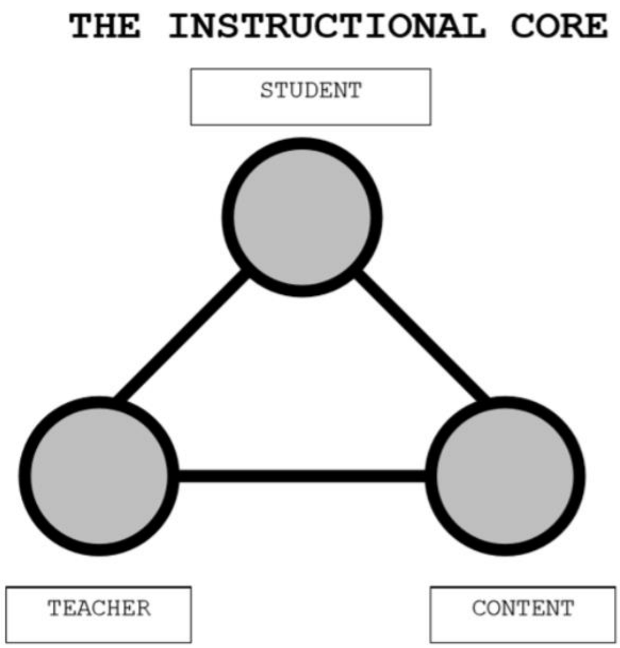


2.2.3 The Instructional Core

Nitkin (2018) defines the instructional core as "the interaction of teacher and student in the presence of content" (p.31). Based on the Instructional Core approach, in order to improve any educational system, we have to focus on three main elements as a bundle, i.e. the student, the teacher and the educational content, and improving any of these elements requires educators to improve the other two elements. Therefore, any research that sheds light on education should consider the three elements and not focus on each of them separately. Nitkin (2018) asserts that in order for a remedy of any of the three previously mentioned elements to be successful, the other two elements should be equally taken into consideration. This remedy should upgrade the content, the teacher's role as a facilitator and increase student engagement and independent learning in order for it to improve student learning objectives. Some researchers believe that the instructional core is so important that uncovering a part of it will render the remedy limited (Nitkin 2018).

The Instructional Core, a notion coined by Richard F. Elmore, suggests there are three indispensable pillars to the ideal educational process in digital learning: content as part of an AI-powered digital learning system, teachers as facilitators and students as engaged and independent learners and everything else is instrumental. Therefore, any alteration to any of the three main pillars means the other two pillars have to be addressed accordingly (Elmore 2008; City et al. 2009).

Figure 2.4 The Instructional Core (Elmore 2008, p.16)



In his paper, Richard Elmore (Elmore 2008, p.16) also touches upon seven principles to improve student learning which named as "seven principles of improvement" (p.16); mentioned below:

1. In order to improve student learning, the three elements of the instructional core should be improved:
    a. The learning content should be raised to a higher level.
    b. The skill sets and knowledge of the teachers should be developed to give students better instruction.
    c. The student engagement with the learning content should also be enhanced.
2. If any modification should fall on any element of the three elements of the instructional core, the remaining two elements must be modified as well. This

means that if the learning content is enhanced, correspondingly, the teachers' skills, as well as students' engagement, should be improved (Elmore 2008, P.1).

Differentiation between students: Elmore believes that students' learning is intrinsically different, even if all students receive the same educational content and undergo the same assessments. For example, teachers have different expectations from one student to another; different teachers have different skills, which leads to students being exposed to a variety of instructional skills; and students receive and understand the learning content differently; some students just do what the teacher asks them to do, other students apply what they learn and make connections. All of these factors work together to eventually result in different levels of student learning (Elmore 2008).

3. "If you can't see it in the core, it isn't there" (Costante 2010, P.4): Any change in the educational system that is not directly linked to the three of the pillars of the instructional core does not lead to the improvement of student learning. It does not matter how much money is spent on developing and enhancing the school premises or on introducing new technological platforms if such strategies do not cover the three pillars of the instructional core (Elmore 2008).

4. "Task predicts performance" (Costante 2010, P.4): This principle focuses on determining what a student is able to do based on their level. Students' results should reflect what tasks they are capable of doing and their improvement (Elmore 2008).

5. "The real accountability system is in the tasks that students are asked to do" (Costante 2010, p.4): Accountability should be associated with each student's ability to do the task and their understanding of how to do the task and the objective behind doing it. Elmore also believes that the task should give a sense of accomplishment and satisfaction to both the student and the teacher (Elmore 2008).

6. "Learn by doing the work" (Costante 2010, p.4): Elmore believes that the individual learns best while actually working on the task and not from having someone else work on it. He also suggests making students take rounds applying the instructional core to each other. The teacher can follow this method by dividing students into groups and having those groups observe, evaluate, and reflect on each other's work (Elmore 2008; Meyer-Looze 2015).

7. "Description before analysis, analysis before prediction, prediction before evaluation" (Costante 2010, p.4): Elmore indicates that teachers should describe and then analyse the students' work to be able to predict the next step for the students, which in turn helps the teacher better evaluate and set new objectives for student learning. It is very important that the language used be highly descriptive, as what one person means by a key term, such as student engagement, might mean a completely different thing for others (Elmore 2008; Meyer-Looze 2015).

The educator should consider any negative or positive impact of any development in the education system, such as introducing an AI platform, on student learning and teacher performance. For example, if a new AI-powered digital learning system is implemented in the school without giving the teachers the proper training, this system results in a negative impact on first the teacher and, consequently, the student. Moreover, the way the teacher deals with this system has its own influence. If the teacher fully depends on the system to teach the class, this definitely limits and gradually decreases the teaching capabilities. Besides education, the main role of the teacher is to provide students with emotional support and enhance their personal morals, a role that AI is not capable of fulfilling.

2.2.4 Adaptive system for learning

Today algorithms can more effectively and efficiently process information, including taking into account uncertainties (e.g. fuzziness) as part of the decision-making process. As a result of the rise of AI, experts have designed new frameworks that help understand how AI and technology developed the education system to support student learning with an adaptive system dedicated to each student, what is known as individualization. “AI is bringing an opportunity for individualization to the entire educational system” (Yang 2019, p.350). As Hasse et al. (2019) mention, “Artificial intelligence systems are already enhancing the field of education by enabling a more customizable approach to teaching and learning” (p.19).

According to Tsortanidou, Karagiannidis & Koumpis (2017), adaptive e-learning attempts to personalize the learning experience for the learner. This learner empowerment can help to improve learner satisfaction with the learning experience. This leads to the second key term: individualization. The core role of AI is personalizing and individualizing the learning process according to each student’s needs and skillsets.

Intelligent tutoring systems (ITSs) “support problem solving by providing adaptive scaffolding in terms of feedback, guidance, problem selection and other types of help” (Najar, Mitrovic & McLaren 2016, p. 460)

According to Cavanagh et al. (2020), during the process of developing content, learning concepts and lessons are divided and arranged in a structure that guarantees the learner perfectly masters a prerequisite concept before moving onto the next one. The system starts the cycle of adapting to the learner’s level by, first, collecting information that tells the system what the current level is. This is done by giving the students a short version of the placement activity, the result of which helps the system determine where the learner is at. This is the main and most important step for a strong remediation and adaptivity learning system.

There are several algorithms that can be used in an adaptive system to define the basis on which the remediation content is provided. Cavanagh et al. (2020) think that an adaptive system can combine these algorithms to fit different situations; these adaptive algorithms are: “machine-learning systems, advanced algorithm systems, rule-based systems and decision-tree systems”, (Cavanagh et al. 2020, p.2).

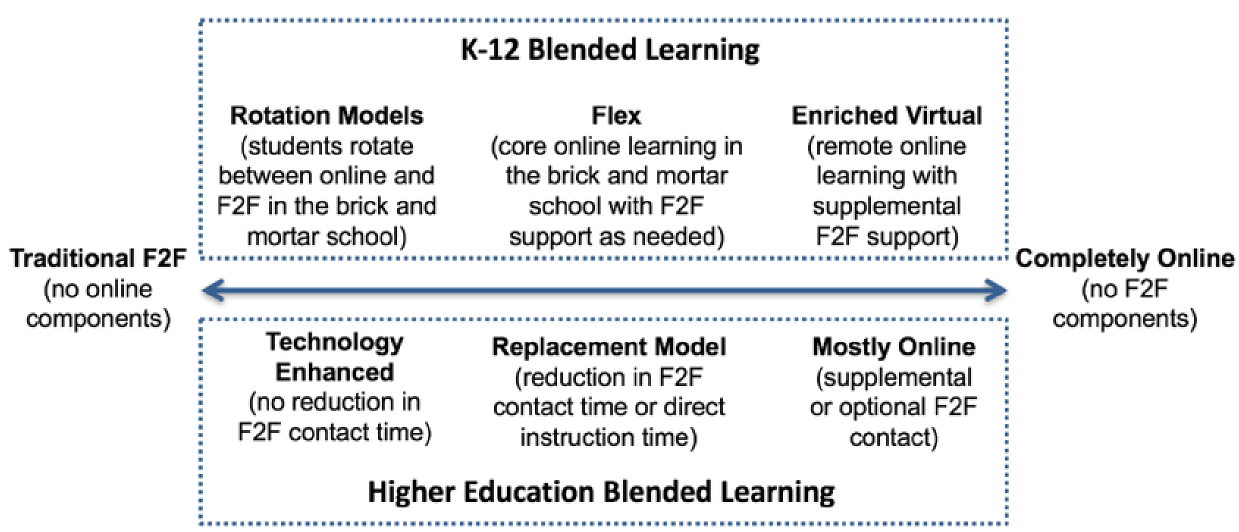
Besides algorithms, analytical insights present an important part of adaptive learning. When students or learners use an adaptive system, they provide personalized feedback, which in turn is channelled into the analytical data page to provide the teacher or educator with immediate data that allows them to take action (Cavanagh et al. 2020). The type of data that is collected in an adaptive system includes the time a learner spends on a specific part/page, the effort that a learner has given on that part/page, as well as the number of attempts the learner makes at answering certain assessment questions included in that part/page. Current adaptive learning systems give the teacher the chance to gather this information on the level of individual students as well as on the level of the whole class. Cavanagh et al. (2020) believe that adaptive learning systems focus their attention on the student and help teachers make the right intervention to close the learning gaps for students before these gaps extend to be so big that it is no longer a potential to bridge them. However, there are several variables that, according to Cavanagh et al. (2020), contribute to a successful adaptive learning system; create a prerequisite mapping, creating a map (or graph) that correctly structures concepts according to their level and sets the right prerequisite for them; then create assessment activities and questions of different types, i.e. numeric and textual; followed by linking each bit of content to another as a condition for a student to master one before moving on to the other. This doesn’t necessarily mean that one should directly precede the other. In some cases, the linkage can be between two different subjects. Teachers should be given a chance to present the learning content in various modes, namely, in scripts, multimedia, as well as other interactive modes (Cavanagh et al., 2020).

2.2.5 Blended Learning

Blended Learning has recently gained momentum with regards to its implementation in K-12 schools and higher education (Graham et al. 2017). According to Graham et al. (2019), blended learning is a combination of two teaching methods, namely: online and face-to-face instruction. In the past, the implementation of blended learning was hard to track due to limitations of the digital resources as well as the lack of tools that enable educators and teachers to track and collect students’ data (Graham et al. 2017). Blended learning is not merely an integration of technology into the classroom setting; rather, it should constitute an experience for students that includes online learning, where they can manage their own learning according to the preferred time, speed, place and in the pace that best suits their academic level (Graham et al. 2019).

According to Lu & Price (2021), e-learning technology is considered a type of blended learning, where the student and teacher can fulfil their respective needs. Lu & Price (2021) claim that blended learning is used universally and that it has supported the transformation in the education field and positively influenced students' motivation. However, successful implementation of blended learning requires both students and teachers to have ICT skills that enable them to efficiently communicate with their colleagues and teachers and to be independent learners who can manage their learning based on their performance data. According to Black, Ferdig & Thompson (2020), blended learning adds a big value when it comes to students and/or teachers who have special health issues that could hinder their attendance to the school in-person. In such cases, where it is a must for students to stay at home or be hospitalized for health-related reasons, blended learning is the ideal solution to ensure that their learning is not disrupted. Pulham & Graham (2018) found that blended learning where teachers partially instruct their students online can protect and retain such teachers from quitting their job due to a more convenient and affordable online teaching environment.

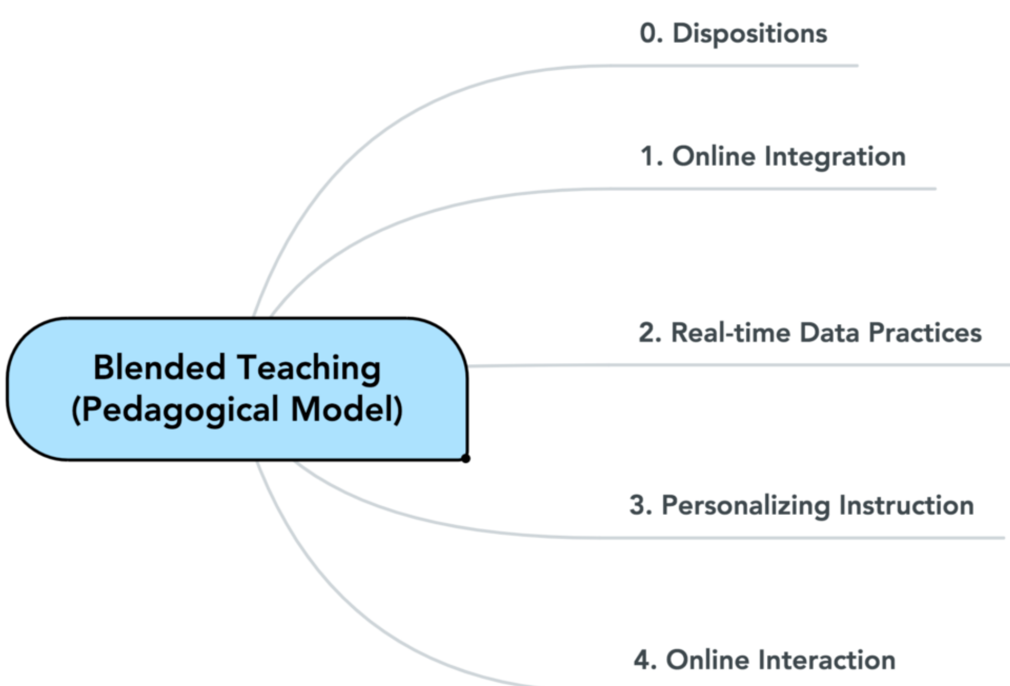
Figure 2.5 Spectrum of blended learning models for K-12 and higher education (Graham et al. 2017, p.7)



As shown in the above figure, Graham et al. (2017) classified K-12 teaching methods in general into three categories: traditional in-person teaching and learning and online teaching and learning, both placed at the far end of the spectrum, and blended teaching and learning, which is a combination of the two previously mentioned models. Graham et al. (2017) further specified three types of blended teaching and learning according to the extent of applying online or face-to-face teaching and learning. The first type is the Rotation Models, where students equally use both online and face-to-face learning as primary methods inside the school. According to Fathin et al. (2020), this type promotes an enhanced understanding of the learning concepts and positively influences the academic accomplishments of the students. The second type is the Flex learning and teaching model, where students use online learning as the primary learning method inside the school and resort to face-to-face learning only when support is required. The last and third type is the enriched virtual learning, where students study and learn remotely via an online program with supplementary face-to-face learning as needed.

Graham et al. (2020) claim that there are a number of elements that work together to ensure blended learning is implemented successfully, as shown in Figure (2.6) below. The first element is the disposition, which describes the willingness of teachers and students to adopt blended learning and teaching models. The second element is online integration, which describes the ability to efficiently merge online and face-to-face learning and teaching. The third element - Real-time Data Practices - covers the necessity of having access to real-time data on students' progress and the ability to leverage this data to monitor and guide learners' improvement. The fourth element is personalizing instruction, which depicts the ability to implement adaptive digital learning tools that customize learning objectives for students based on their individual abilities and levels. The fifth and final element is facilitating the online communication between the students and with the students to achieve the ideal implementation of blended learning.

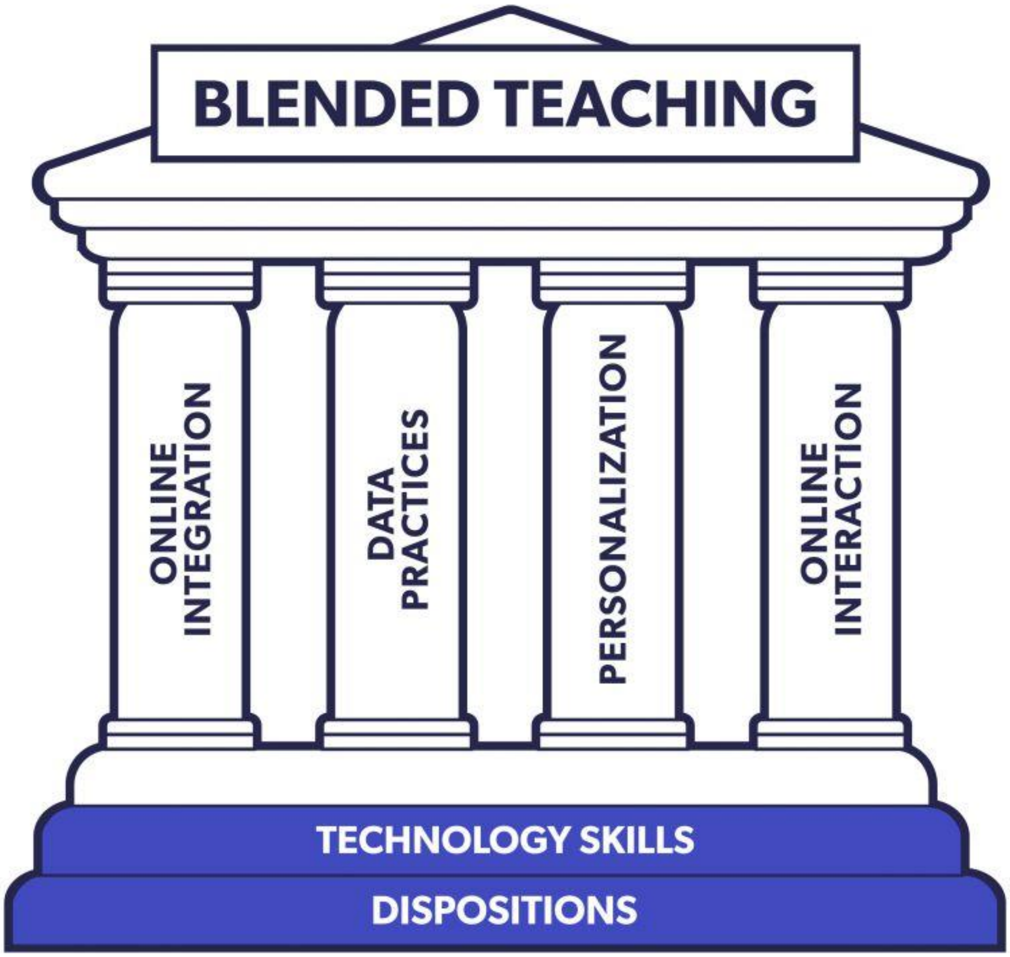
Figure 2.6 Pedagogical Model for Blended Teaching Competencies. (Graham et al. 2020, p.4)



Blended learning core skills for teachers

According to Graham et al. (2019), teaching a blended learning model required acquiring four core skills in order to implement it successfully, as shown in Figure (2.7). The first skill is online integration, which is the teacher's competency to successfully combine both methods: online teaching and face-to-face instruction. The second skill is the ability to utilize the student data collected via online platforms on their work and activity to help support students and maximize their learning. The third skill is personalization, which describes the teacher's ability and disposition to leverage online platforms to customize the learning material according to each student's abilities, pace and academic level. The fourth and last skill is empowering students to efficiently communicate and interact with their peers, teachers, as well as with the interactive online learning materials.

Figure 2.7 Blended Learning Core Skills (Graham et al. 2019 p.1)



According to Yeigh et al. (2021), for blended learning to be successfully implemented, a number of requirements are necessary to be present, such as having a dedicated team to manage and lead this implementation as well as organizing teacher training workshops so that they are more confident of their capabilities once the implementation starts. Additionally, evaluation and assessment measures need to be put in place to be able to study the progress of the implementation of blended learning.

Benefits of Blended Learning

Graham et al. (2019) gathered the benefits of blended learning under seven main points within a system he called The P's as each benefit starts with the letter P, as explained below:

1. Participation: According to Graham et al. (2019), one of the main issues in traditional learning and teaching is unequal chance to share ideas. Over the years, teachers came up with a number of solutions to try and solve this issue by, for example, putting students into groups and having them share ideas with each other; however, even then, only one or two students in each group would have the dominant word. With the advent of online learning, students can freely contribute to the lesson and share their ideas directly with the teachers so that by the end of the lesson, instead of the teacher having heard a small number of students, they would receive the participation of the whole class.
2. Pace: In the traditional class setting, the teacher instructs, and students receive; the teacher addresses the class as a whole, they don't address each student individually. On the other hand, blended learning allows students to progress at their own pace while having the option to keep practising specific concepts until they reach the mastery level, after which they can advance to the next one (Graham et al. 2019).
3. Personalization: According to Graham et al. (2019), personalizing the teaching and learning in a traditional classroom setting becomes a difficulty that can be easily overcome with online learning when the right methods of teaching and data collection are applied. Additionally, blended learning enables students to own control over their learning, which in turn helps them direct their education to better suit their abilities. In the same way, Arnesen et al. (2019) argued that personalization in learning emerged before the advent of

technology; however, digital learning has contributed hugely to an advanced personalized learning approach and supported blended learning to serve students' individual needs. Personalized learning equally enables students to share their own opinions and choices regarding the content they choose to learn as well as the time and setting to learn it. This flexibility in learning allows them to better master the learning concepts.

4. Place: Graham et al. (2019) argue that blended learning gives students the opportunity to learn using the digital platforms at any place that best suits their needs and circumstances, whether it is at home, school, at the hospital, or any other place. According to Arnesen et al. (2019), blended learning provides students with control over the place and setting they choose to get their education, in addition to the freedom of picking the time and pace of their lessons.
5. Personal Interaction: Blended learning allows teachers to make up for the lack of equal focus during the traditional classroom setting using the features embedded in the digital learning tools to focus on the individual needs of students, (Graham et al. 2019).
6. Preparation: The digital learning tools employed in blended learning provide the opportunity for students to have access to the interactive learning material and prepare themselves for the class, whether the online or in-person class and in the same way after the class in case the student would like to go over the learning material once again, (Graham et al. 2019).
7. Practice with Feedback: Feedback represents a vital factor in the learning process, and nowadays, with blended learning, the AI-powered platforms used for online learning and teaching provide students with immediate and relevant feedback about their online activity

and work, in addition to some hints to help them better understand and solve the problems and assessment questions included in the learning material, (Graham et al. 2019).

Arnesen et al. (2019) describe personalized learning as making students co-creators of their learning by giving them more power to choose what they learn. Arnesen et al. (2019) argue that in blended online learning, there are three parties involved in the customization of student learning: students - in a process referred to as personalization; teachers - in what is known as differentiation; and the online learning tool itself, which can make choices on behalf of the students based on the performance data it accumulates over time; in this case, the online learning tool is considered an adaptive learning software.

How Blended Learning Transforms the Teacher Role

Blended learning, powered with the cutting-edge features included in online digital learning, transformed the teacher's role from being mere instructors into coaches and facilitators. According to Garahm et al. (2019), the role of the teacher in a blended learning environment is significantly different from that in a traditional teaching setting in several ways. First off, the teacher no longer acts as a lecturer in the classroom but more as a facilitator. Secondly, online learning tools enable the teacher to dynamically use different students grouping methods during the lesson. With the capabilities provided by online learning tools, the teacher no longer has to use up the class time explaining the learning material for the whole class at once. Instead, the teacher can focus on intervening to support students according to their individual needs. The teacher's main focus moved from only the content to improve students' skills and mindset by developing their critical thinking, creativity and innovation skills. Graham et al. (2019) argue that blended learning helps the teachers bring out the best in them by focusing on their strengths and being creative by specializing in what they do most competently. For example, some teachers find that they excel in writing assessment questions, which means that they are more specialized in this area; so, they can harness and improve their capabilities to author assessment questions most relevant to students' learning objectives and share them with their colleagues.

2.3 Literature Review

In this section, the researcher presents the previous literature relevant to the main topic of this paper. The researcher includes previous papers that either supported or argued the thesis and analyzes the findings that the previous researchers reached at. AI digital learning is a major topic under which many subtopics fall. Extensive previous research has been conducted on these subtopics. The Literature Review Chapter refers to the key findings of these studies and how these studies support this thesis.

Technology is taking over the world market, and it's making the world go around. Every day innovative ideas are being created to make life easier for the human race. Technology also allows students to tap into knowledge quicker, to be more resourceful in their needs, and to eventually become more independent in their learning. When the technology first came on the market, we were trying to figure out how to use it, but now we are becoming more competitive in how to manipulate it. As educators in the 21st century, we should recognize that students today are different from students ten years ago. Digital age students have different skills, and they require different needs, especially in education. According to Olive (2011), almost one-third of high school students in the US leave school before they complete their diploma because schools are performing the same way as schools did in the 19th century. Technology today is available to be used for reform teaching and learning and makes learning available everywhere and anytime inside and outside schools. Online learning does not need a time zone or location; students can access the learning materials anytime and from anywhere (Anderson 2008). For these reasons, digital learning has become a demand; however, it is necessary to investigate its influence on student learning and ascertain that impact on student learning is positive. Emerging new technology, digital learning, digital learning, and all web-based learning provide the "opportunities to transform education, learning, and teaching" (Veletsianos 2016, p.9).

Today's students are exposed to technology since their birth. Therefore, the whole process of education must change to attract students' engagement and motivation to learn; learning should become a fun, and engaging process, and the skills and knowledge taught should be linked to the interests of the learner. According to Beetham and Sharpe (2013), "All our educational ambitions for the post-compulsory sector are challenging: personalized learning, higher attainment standards, wider participation and improved retention in further and higher education, closer relationships between education and the workplace, lifelong learning, a more highly skilled workforce for our knowledge economy" (p.16). According to Xu and Bi (2017), the students who study through digital and digital mediums have more self-efficacy and better capabilities than others who don't.

The advent of AI has added value to digital and digital learning as it is learning from a distance and can be done via various tools that are made available on a screen, it can be a video or a book in a Portable Document Format (PDF) or even as an audio file or interactive activities. Online learning could also go further by creating a channel of communication between a student and a teacher using a video call app, such as Skype, or even via email. However, when powered with Artificial Intelligence techniques, digital learning is elevated to a whole different level.

Fundamentally, AI means that the machine or, in the case of this research, the platform, is intelligent and is able to make the decision based on Big Data. Using the data fed into the platform, it can learn and make a decision on its own without the need for human intervention. An AI-enabled platform provides direct feedback for the students about their work. It can go further and define the student's needs and the specific skills that they may or may not lack.

In a study conducted by Stone et al. (2016), the next area of focus in AI and education should be the quality of communication and interaction between humans (students and teachers) and the AI technologies and software used. There is a growing development of machine tutors and chatbots to support teachers and students by answering students' questions whenever needed and serve the different needs of students of all levels by providing them with personalized learning content that suits their pace of learning. Stone et al. (2016) also attempt to visualize the impact of AI in the next 15 years, and they predict that AI will help schools and teachers to multiply their class size while, at the same time, being able to meet the different learning styles and requirements for each student on an individual basis.

When developers and researchers started studying the idea of digital education, the original aim was to solve and make available what traditional education does not make available, which is education for all (Wogu et al. 2019). The concept of MOOCs (Massive Open Online Course) first came to life when teachers started making parts of their lectures available digitally for one reason or another (Wogu 2018). After that, more platforms were started to help make knowledge available to everyone and everywhere for free. This called for the need for tools that not only provide educational content but also optimizes the methods of learning, such as the Summit Learning

Platform, which is created to support students' learning by helping them track their progress and compare it against their learning goals (Wu et al. 2020).

The integration of technology in the education system was limited in comparison to other areas and industries, such as integrating speech, voice and image recognition technologies for security purposes. Nonetheless, according to Murphy (2019), the attention towards educational technology has been increasing over the years. It is currently a major industry that witnesses fierce competition in designing comprehensive and smart AI-powered platforms and applications that best support teachers and students in schools. Yet, there is a need for more research and studies to support the positive impact of such applications on the K-12 learning ecosystem (Murphy 2019).

Murphy (2019) divides AI application in education into two main categories: the first category is based on a set of rules, the results of which lead to achieving adaptivity in learning. The second category consists of platforms and software that are designed, following the machine-learning process, to detect patterns and provide correct automated results, such as auto-grading and auto-correction applications.

2.3.1 AI-Powered Platform Statement and Role

The main purpose that called for the start of digital learning was to provide affordable, flexible, high-quality and up-to-date education that can be assessed and matched to the level of interested learners from around the world. According to Wogu et al. (2019), serious and promising indicators to the start of MOOCs (Massive Open Online Courses) was in 2011. Sabastian Thrum from Stanford University wanted to make specific parts of his classes available for free digital for anyone who would like to benefit from them. A few months after Sabastian launched his initiative, more than 160,000 students registered in this digital course. According to Wogu et al. (2019), this course marked the beginning of the emergence of AI-powered digital platforms, such as “Udacity, edX, Coursera, Wiz, IQ, UPEx, iversity and Stanford Online" and many others. The major reason behind configuring AI in the digital learning platforms is the need for an automated grading tool, a part of AI, to help assess and test the huge number of registered learners, reducing the human effort and time by multiple times. Previous studies reported that making high-quality education accessible to everyone as well as the continuous rise of innovative AI applications in digital platforms is nowadays considered a turning point in digital education. Wu et al. (2020) suggest that using mobile and portable devices and the increase of the number and types of AI-powered platforms contribute to the growth and spread of digital and distance learning.

2.3.2 Examples of AI Educational Platforms Around the World

This section introduces a number of AI educational platforms implemented in different regions around the world, a few of which have been mentioned above; it also talks about the different functions, userbase, learning model, geographic location.

2.3.2.1 Udacity in the UK

As mentioned in the previous section, Massive Open Online Courses, commonly known as MOOCs, witnessed a significant spread. One year after its launch in 2011, many platforms came to life, such as Udacity, Coursera and EdX. According to Anyatasia, Santoso & Junus (2020), Udacity was established in 2011 as a profitable digital learning platform that mostly taught about technology. The beginning of Udacity was when Sebastian Thrun and Peter Norvig worked together to launch the digital course “Introduction to Artificial Intelligence”. This course was a huge success as more than 160,000 learners joined from more than 190 different countries around the world. Up until 2014, Udacity included courses that are on par with university courses. However, it later changed its main concept and decided to start training and preparing learners for the requirements of the technology market. Udacity divides its Computer Science courses into several categories: “School of Programming, School of Artificial Intelligence, School of Cloud Computing, School of Data Science, School of Business, and School of Autonomous System.” The courses are also divided as per the payment factor: the paid courses are under the Nanodegree category, while the complementary courses are listed under the free course category. The courses that are part of the nano degree on Udacity include an instructor that guides and teaches the students in addition to providing feedback and assessment of the assignments that students submit (Anyatasia, Santoso & Junus 2020).

2.3.2.2 Classera in Saudi Arabia

According to Alhujayri (2018), Classera was established with the aim to address students in the Middle East, with a higher focus on Saudi Arabia. In 2017, approximately 150 schools across the Middle East used Classera, a major part of these schools were private. Although not much data was collected at the time, Classera was considered prevalent in the Middle East market, save for a number of virtual learning platforms that were aligned with the American Curriculum were used, such as Moodle and Blackboard. Classera witnessed a skyrocketing increase in usage when an advanced school in Riyadh started using the platform. In addition, in 2015, Classera launched its virtual learning initiative to help students who lived in areas where schools are no longer accessible (Alhujayri 2018).

Alhujayri (2018) defines Classera as a virtual learning environment (VLE) that provides learners with a lot of functionalities that can be classified into five main ones, as shown below:

1. Communication: Classera ensured that communication is maintained between all the stakeholders involved by launching:

- Discussion Boards: The main goal of setting up these boards is to allow students and teachers to have a space where they can initiate discussions virtually (Alhujayri 2018).

- Automated E-mail and SMS Notification System: to ensure students and parents are kept abreast of the new developments and events taking place in the school. It also has the function of notifying the parents about their children's performance and if their child is registered as absent (Alhujayri 2018).

- Internal Messaging System: In addition to the discussion boards, Classera provides teachers and students with another way to communicate with each other; this could be between the teachers with themselves, the students and themselves, as well as students with teachers (Alhujayri 2018).

- Alumni Club: Classera ensures that its students are still kept in touch with their teachers even after they graduate through the virtual alumni club. This means of communication allows teachers to stay informed about the news and developments of their students' professional and educational lives (Alhujayri 2018).

2. Administration:

- Student information system: to maintain a record of students' data, such as their attendance record, class schedule, test results as well as a record of their behavior (Alhujayri 2018).

- Teacher management system: Allows school principals and administrators to view the needed data about the teachers, such as daily attendance, class schedules and performance (Alhujayri 2018).
- Financial Module: acts as a communication point with the accounting department in the school. This module helps manage the school's balance sheets, process and keep track of the transactions made in the school (Alhujayri 2018).

3. Learning:

- Distance learning (virtual classes): Classera gives teachers the option of arranging virtual classes, if need be, after school hours (Alhujayri 2018).
- Questions Bank: a repository of assessment questions and activities that teachers can choose from. Classera also allows teachers to create the tests on the platform beforehand and give students a specified amount of time to answer the questions as the teacher sees fit. Teachers can also assign assessment activities to students that they have to submit before a deadline that the teacher decides (Alhujayri 2018).
- Custom Content Library: Teachers can create their own learning materials and share it with each other via this content library that is accessible by teachers who have a Classera user account (Alhujayri 2018).

4. Reports:

- Grade Book and Transcript Management System to maintain a record of the grades that students get in tests and assessment activities (Alhujayri 2018).

- Electronic Certificates are issued to recognize the teachers who prove a consistent usage of the workshop attendance feature. Classera ensures that certificates are sent to teachers securely by requesting a verification before being able to view the certificate (Alhujayri 2018).

- Survey Module: This module represents a great way for the school to collect data from its students and staff members. The school can choose to send a survey or questionnaire to its students to learn about their opinions on newly applied courses, etc., (Alhujayri 2018).

- Business Intelligence Module to help principals view data on the level of the school (Alhujayri 2018).

5. Rewards and encouragements; Points and rewards: teachers and students can win points as they use the platform. Once they reach a specific limit, they can win different kinds of rewards and excellence badges that they can redeem in entertainment facilities, restaurants, etc. (Alhujayri 2018).

- Classera Talent Club: Classera encourages high-performance students by providing them with a free membership to the Talent Club.

- Educational Games: Classera provides learners with bonus educational games as a reward to support their learning journey (Alhujayri 2018).

2.3.2.3 Squirrel AI in China

Squirrel AI Learning was established in 2015 in Shanghai, China, with the aim of utilizing the most developed artificial intelligence technologies and the data collected over the years to be able to efficiently predict the student's level of performance and accordingly recommend the needed education and providing an adaptive learning path for each student as determined by the AI engine used in the platform (Shenshen 2020). According to Hao (2019), Squirrel AI Learning captures millions of data points to enable them to design the platform in a way that can personalize the student learning experience according to their educational needs.

With the amount of data collected, Squirrel AI Learning created an adaptive learning system, which later can be seen applicable in all grades of schooling, starting from kindergarten and including preparing employees for the 21st-century workplace requirements. Hao (2019) describes Squirrel AI as a highly granular and scalable platform as it employs subject matter experts to work with the engineering team on dividing the curriculum into atomic and micro concepts and skills, known as knowledge point, linked and structured according to the relationship between them and as part of a comprehensive and connected Knowledge Graph. This helps them identify students' knowledge gaps in a highly accurate manner. Once the gaps have been identified, the platform recommends the learning content that is associated with these knowledge points (i.e. gaps) based on the relationships between these points in the knowledge graph (Hao 2019).

According to Shenshen (2020), Squirrel AI Learning is the first domestic adaptive learning engine based on the advanced algorithm and with completely independent intellectual property developed by YiXue Education. Squirrel is the symbol for "agility, diligence and management." This aligns with the experience Squirrel AI Learning provides for its students to help them advance learning through the real-time adaptive system and cultivate good learning habits with practice.

Squirrel AI provides personalized after-school tutoring centres for students from elementary to high school. There are many factors that contribute to the rise of educational AI platforms in China. First, due to the huge population of the country, the competition to acquire the best education is very high. Therefore, parents do not consider schools sufficient for their children, and they constantly search for other after-school tutoring centres to remediate their children and improve their scores. Second, the quality of education in most public schools is not up to the standard due to a shortage of qualified teachers and the very high average number of students in the class, which can range between 50 to 70 students in one class. These reasons, amongst many others, push the parents to seek additional educational systems despite the high cost that they will have to bear (Shenshen 2020).

2.3.2.4 ALEKS in the United States

The Assessment and Learning in Knowledge Spaces, commonly known as ALEKS, is an AI-driven adaptive platform based on an assessment tool that started in the United States. The major function of the platform is to help students define the areas they master in mathematics as well as the areas they struggle with. Nwaogu (2012) conducted research to study the effect of the platform on students' performance in mathematics in a virtual classroom setting as well and to measure how well students perceive their assignments in math by comparing the results of the assessments done before and after the test. Nwaogu (2012) found that ALEKS had impacted the students' performance in the mathematics course significantly; however, the time students spent on the ALEKS platform did not have a correlation with their performance improvement in mathematics (Nwaogu 2012).

2.3.2.5 Next Education in India

Next Education was established in India in 2007 by two aspiring entrepreneurs: Dev Ralhan and Raveendranath Kamath, with the aim of motivating K-12 students to learn by creating a fusion between education and technology. Over the course of 10 years, the platform grew to reach over ten thousand schools across India, impacting the education of more than twelve million students (Yadav, Gupta & Khetrapal 2018). Later on, Next Education company started several platforms that are aimed at catering to specific needs and requirements; some of these platforms are TeachNext, LearnNext, MathsLab, Next ERP (Enterprise Resource Planning), (Yadav, Gupta & Khetrapal 2018).

2.3.3 Student Engagement with Online Learning

According to Mucundanyi (2019), it is very important to attain and maintain the engagement and attention of the students in order to achieve retention and complete the courses at hand. Student engagement contributes to the overall quality of the education the learner gets (Robinson & Hullinger 2008). According to Price and Tova (2014), creating strategies and policies in educational institutions of all kinds that ensure active and collaborative teaching practices are implemented in the classroom and that learners are constantly being provided with the needed support leads to higher engagement from the learner, which in turn leads to better performance and results (Price and Tova 2014, p.780). The educational institution holds the lion share in the responsibility of intriguing the learner's attention. There are many challenges that such institutions face when trying to increase student engagement with digital learning (Sher 2009). Ahlfeldt, Mehta, and Sellnow (2005) believe that one of the main challenges that educators face with digital learning is adapting to the change in students' attention spans while learning digital, in addition to many other changes that keep arising over time (Ahlfeldt, Mehta, and Sellnow 2005, p.5). Educators and researchers alike worked on finding ways to increase student engagement, for example, by focusing on student skills, emotions, interaction, or performance to help measure and compare engagement rates (Dixson 2010; Handelsman, Briggs, Sullivan, & Towler 2005). Some researchers tried to dig deeper and study student engagement based on the student's interaction with: the teacher, other classmates, and the learning content (Young & Bruce 2011; Strachota 2006; Dixson 2010; Sher 2009).

Chickering and Gamson (1987) put in place seven principles for a good teaching practice that can be applied to digital learning: 1) spreading the environment of cooperation and group work between students and 2) between learners and their teachers; 3) implementing unique and interactive teaching methods; 4) providing immediate feedback; 5) giving value to the time spent on assignments; 6) informing the learner what is expected of them, and 7) accepting that learners have diverse talents and that each learner has his/her own way of learning.

With the emergence of digital learning, research has been transformed to study and investigate student engagement with digital and digital learning platforms. According to Lee et al. (2020), many researchers worked on analyzing students and learners' behaviour on digital platforms to try to arrive at a pattern that can help come up with a set of factors that impact and possibly define what engages students. Lee et al. (2020) point out that over time, studies become more narrowed towards investigating a particular area rather than a generic one. Some studies even found out that a student's behavioural engagement doesn't necessarily mean that the student is cognitively engaged.

2.3.4 The Added Value of Using AI-Powered Online Learning Platforms

Previous research that studied the impact of digital and AI-powered learning in many schools and universities across the middle east found that using digital smart learning in education resulted in higher student engagement and efficiency. According to Mohamed, Al Barghuthi & Said (2017), applying digital learning in the United Arab Emirates University helped create better opportunities for university students in various ways by facilitating access to information, education resources and helping them conduct their research. It also allows students more flexibility in terms of the availability of the educational resources needed anywhere and anytime, which helps students be more focused. Additionally, students registered at a higher engagement rate and enjoyment in learning when digital learning is employed (Mohamed, Al Barghuthi & Said 2017). A study conducted by Gunn & Raven in 2017 in the Middle East supported the findings of (Mohamed, Al Barghuthi & Said 2017), as it claimed that digital learning enhances learning activities with positive effects and that learning happens when a student is fully engaged (Gunn & Raven 2017). Additionally, Baker, Goawda and Salamin, (2018) noted that the Alef digital education system used by Abu Dhabi public schools and charter schools in New York City was built based on the principle that provides students with many opportunities to engage in learning, such as multiple materials, videos, games and texts, clear outcomes in each lesson, assessment with direct feedback after each learning objective, stars and credits after multiple items which motivate students to be more engaged in learning, practice learning skills anytime and anywhere with direct feedback which enable the student to reflect in what they learn (Baker, Gowda & Salamin 2018).

Guo, Kim & Rubin (2014) proved that videos engage students to learn more than traditional lecture; however, short videos show more engagement than long videos, and students are more engaged with drawing videos than high-quality lectures. With videos and games, lessons become more on the level with students' maturity allowing them to learn with an activity they like, which makes them more engaged (Guo, Kim & Rubin 2014). The research findings by Eseryel et al. (2014) suggest that students are motivated by digital learning games; these games promote student engagement and motivation to complex problem solving based on the curiosity of designing these games. Tempelaar, Rienties & Giesbers (2015) suggest that the continuous formative assessment for learning outcomes with meaningful feedback provides a huge power advantage for digital learning systems. According to Lu and Yang (2018), digital material designers must consider different styles of student learning; they should offer teachers holistic learning materials suitable for verbal and visual students' styles. Learning systems should provide different teaching and learning strategies, and digital materials should support students to be interactive with it; students should have immediate access to multiple learning styles (hearing, visual, kinesthetic). When you give students the opportunity to learn in the style they prefer, they are more likely to master the information and increase knowledge in that subject area. Chen and Huang (2018) explored that teaching strategies using digital education systems are suitable and appropriate to different learning styles. Adaptability is a very important issue in web-based learning systems (Chen & Huang 2018). Chen and Huang (2018) suggest that content and digital material should be customized for students based on their skills level and knowledge. Each student should have different learning goals linked to students' needs and attitudes (Chen & Huang 2018). Bray and Tangney (2015) propose that digital learning increases learner' engagement and confidence. With digital technology, students can become more resourceful without needing human contact, they are also motivated to use it to understand what interests them. Alshayeb (2018) suggests that students are satisfied when using social media technologies as digital learning materials, and they feel it improves and enhances their learning. Technology allows students access at any time and anyplace; it also enables students to practice the activities they like to learn with (Alshayeb 2018). Additionally, it gives students the chance to communicate with peers at any time so that they can reinforce or teach learning objectives and with their teachers for clarification and extra help; it also allows them to access the curriculum outside the classroom, such as different platforms and activities (Alshayeb 2018). Technologies and digital learning empower students to be independent learners so they can learn anywhere and anytime. Online learning delivery platforms can personalize learning for each learner (Mirra, Morrell & Filipiak 2018). Youth and children in the digital age must be considered by educators and decision-makers; the power of digital learning should be connected to enhance students' innovation and engage students to be creators and inventors for new knowledge (Mirra, Morrell & Filipiak 2018). Taylor and Parsons (2011) notice that students who use the technology with accountability measures have seen more engaging behaviours with positive outcomes for time on task, engagement approaches in digital learning advanced as a method to help manage classroom behaviour. They also emphasize that learner engagement has been developed with the hope and aim of enhancing all learners' capabilities to "learn how to learn or to become lifelong learners in a knowledge-based society" (P.4).

Although (Wu et al. 2020) seconds that E-learning has left a positive impact, he points out in research he conducted in 2020 that it has also caused a negative influence on the students. Wu claims that the main side effect is causing students to feel socially alienated and detached while learning digital as students will have to learn without face-to-face interaction with other students and with teachers. This could potentially lead to gradually growing frustration and lack of motivation to keep learning (Wu et al. 2020).

In an attempt to solve this problem, an "E-Learning Assistant ChatBot" was installed to support students and answer their needs throughout the day. The National Central University and Engineering Yuan Ze University conducted research with the support of the Ministry of Science in Taiwan to study the impact of this chatbot on students and to investigate whether it has helped students overcome their feelings of isolation. The main result of this study indicated that the installed chat bit helped to decrease the feelings of detachment. Moreover, students found this feature to be more entertaining than talking with a real teacher and more effective as they receive the response to the inquiries instantly anywhere and at any time, even if late at night. (Wu et al. 2020) recommends in his paper that before installing chatbots for educational purposes, it is important to enrich this chatbot with a huge base of knowledge and information to equip it with the data needed to be able to answer any questions related to the course material very accurately (Wu et al. 2020).

Karsenti (2019), Alhujayri (2018), Mirra, Morrell & Filipiak (2018), Benta, Bologa & Dzitac (2014), (Wogu et al. 2019), Wu et al. (2020), and Badica et al. (2019) presented a variety of values of AI-driven digital learning platforms on teaching and learning. Covered below are some of these values as presented by these researchers.

Alhujayri (2018) claimed that AI-driven digital platforms enhanced and organized the dissemination of information and data on the school level; digital platforms help make information easily accessible and manageable by school principals, teachers and the school administration team. Furthermore, this data is securely stored and organized and kept as a historical record of student performance and progress. In addition, creating communication channels between the stakeholders, including the parents, has become doable thanks to digital learning platforms (Alhujayri 2018). It is noteworthy that all data is kept secure and is privately stored. Students' data and personal information are kept protected and secured by the cloud hosting technologies implemented in AI digital platforms. This ensures students' privacy by storing their information and day-to-day activity data in a secure cloud (Mirra, Morrell & Filipiak 2018).

With AI digital platforms, students can learn anytime and anywhere they are in the world, and they can also assess their learning and complete their exams and assignments on these platforms. The AI digital platform can also assess students' level and promote them to a higher level. Alhujayri (2018) said that digital platforms contribute to an enhanced monitoring process of assessments and a developed assessment tool that manages and processes students' assessments in an efficient manner. As a result, AI digital learning supports students to achieve better academic results (Mirra, Morrell & Filipiak 2018; Karsenti 2019). Benta, Bologa & Dzitac (2014) reported in their study that digital and interactive platforms increase the cognitive knowledge of the learners, raise their positive attitudes, which maintains lifelong studying.

AI-powered digital platforms create intelligent ways to interact with the students' data. For example, the AI platform can analyze the student's interaction with different subjects, which can lead to more details on the learning preferences for the student, and ultimately support growing their talent. Another example is using voice recognition to improve students' accents while learning a foreign language (Karsenti 2019). Additionally, AI provides more help to such platforms by enabling them to detect the areas where the learners' difficulties and content need to be enhanced (Wogu et al. 2019). In the same way, AI-driven digital platforms can predict and identify students who might be at risk of stopping their learning and drop out of the school/course, etc. This warns teachers to act and provide immediate support and to tackle the obstacles they face, and heed them away from giving up on their learning.

AI-powered digital learning has transformed the role of each of the stakeholders in education: teachers have become more as facilitators; AI-powered digital learning helps to transform teachers practice from instruction to be more channelled towards coaching (Blundell, Lee & Nykvist 2016).

Moreover, with AI-powered digital platforms, parents have become more involved in their children's education, and they are constantly kept informed about their child's progress so that they can do their part of supporting the learner at home (Blundell, Lee & Nykvist 2016; Alhujayri 2018). According to Karsenti (2019), AI platforms enhance the teacher's performance and support transforming the teacher from a traditional teacher as a mere conveyer of knowledge into a learning facilitator who guides and supports students in their learning pathway. AI-driven digital learning platforms help save teachers' time and effort by utilising the auto-grading features that are built into the platforms. Assessment activities, assignments and tests are graded automatically by the AI-enabled platform, giving teachers more time and flexibility to focus their attention on their students (Karsenti 2019). Teachers are also allowed to live track their student activities and progress on the digital platform, which helps identify the acquisition skills of students throughout their learning journey (Karsenti 2019). Additionally, the AI-driven digital platforms leverage teachers' lesson planning as the data provided by the intelligent platform guides the teacher to make better decisions with regards to the lesson plan. For example, if the teacher notices that most students do not master a certain concept/skill, the teacher can accordingly plan the upcoming lesson to approach the same concept again in a different manner ((Blundell, Lee & Nykvist 2016; Karsenti 2019). Online learning also allows teachers to access a high quality, relevant and diverse range of resources to use in classes, which enables them to use their time efficiently (Blundell, Lee & Nykvist 2016; Alhujayri 2018).

AI-driven digital platforms enable improved detection and management of students' moods and behaviour by empowering school leaders and teachers to monitor and manage students' attendance on a daily basis and to identify the mood of students while learning on the platform so that the teacher can do the right intervention for the student's best benefit. For example, the time spent on a specific subject indicates that the student enjoys learning more about this subject, especially if the learning is not obligatory. Some AI platforms have facial recognition techniques that detect the mood of the students, enabling the educator to take action and make the right decision to ensure the best for the students (Karsenti 2019, Alhujayri 2018).

AI-driven digital learning platforms also leverage classroom management and keep students engaged with the 1:1 interactive learning content while teachers receive live and immediate feedback on the students' activities, enabling teachers to better observe and manage the classroom. The platforms also enable teachers to create educational group competitions on the spot to help keep students fully immersed in the lesson. As per Badica et al. (2019), including the practical aspects and group work can add value to the implementation of digital platforms. Combining applied activities with technology works as a motivator for students to learn, as well as help them to gain teamwork experience and grow the skills needed for future jobs.

Such platforms also support the inclusion of students with special educational needs. There are many features that can be added to digital platforms to help students with special needs and support their learning. For example, students who lack the ability to see no longer need to master the Braille writing system. Instead, they can talk, and the AI machine transfers their speech into written text. Additionally, platforms can include sign language to support students who have impaired hearing (Alhujayri 2018).

On the social level, AI-driven digital platforms create an opportunity for students and learners to connect with each other from all around the world by providing a collaborative and social learning environment. For example, there are many tutoring platforms that provide learners with tutors from around the world to help them master the knowledge and skills in different areas and specializations. This presents an equal opportunity for the teachers and the learners to view and select from a wide network of teachers and learners (Karsenti 2019). Such platforms enable the communication, interaction and cooperation between learners and the content via different intermediate tools, such as the chatbot (Karsenti 2019, Alhujayri 2018). This way, AI digital platforms provide students with accurate, personalized, immediate and frequent feedback on their assessments and activities during their learning journey, which is considered an essential learning component to master the topic and skills at hand. According to Wogu et al. (2019), one of the most beneficial AI features in digital platforms that keeps learners engaged is the ability to give the learner immediate feedback and hints on their performance.

AI digital platforms provide students with interactive and enjoyable learning content, which in turn motivates students to learn more. Wu et al. (2020) suggest that, unlike traditional learning, digital learning platforms empower the student to manage the progress they achieve in their learning as well as accessing unlimited learning resources, which raises the students' engagement and learning efficiency. With the advent of virtual reality and third-dimension techniques, AI digital platforms that include virtual reality and three-dimensional features help students better understand the learning content by making them see, feel and imagine this content. Facilitating these techniques leads to supporting independent learning as one of the main ambitions of educators is to facilitate student learning autonomy. With the help of AI-enabled platforms, this ambition has become a reality that can be achieved and where students can learn independently. Due to the fact that AI-driven online learning platforms intrigue students' engagement where gamification in its content is highly employed in order to make lessons more enjoyable for students, independent learning is supported and enhanced. Gamification is strongly present in platforms that address young learners, and it is considered an essential requirement for such age groups to maintain their attention. According to Badica et al. (2019), motivation is a very important component of education that intelligent learning technologies should consider pushing students to go the extra mile to accomplish their tasks, improve their knowledge and achieve higher results in assessments.

Promoting strategic leadership and efficient management is another value that can be acquired from AI-driven digital platforms. Learning management systems simplify administrative duties and responsibilities on the school level, such as taking students' and staff members' attendance, keeping a record of their details, grades and reports and maintaining a comprehensive portfolio for each student throughout their learning journey.

Robots as teacher assistants are one of the major emerging technologies of AI-driven digital platforms in order to further support teachers in the classroom and optimize their time and efforts; human-like and toy-like robots have been created to assist teachers by taking off their chest the routine and menial tasks in addition to responding to students' questions and providing them with information as requested. According to Wogu et al. (2019), AI further supports digital platforms by allowing students to receive the additional support they need from AI tutors on the platform. Wu et al. (2020) mention a few examples of chatbots that have proven to help students and teachers in the classroom. Some chatbots can help students solve mathematical problems just by giving them detailed and structured instructions on how to solve any math problem that students find difficult to solve. Other types of chatbots can help students organize their learning timetable and courses and feed the learner with more information pertaining to the course, and set reminders of the exam and assessment deadlines. Some chatbots are developed to hold natural-sounding conversations with the learner to guide and tutor the students throughout their distance learning experience. Such chatbots are designed to not only sound human-like but also to look and act as one (in 3D) to raise the impression that there is a real teacher giving them the emotional and educational support they need (Wu et al. 2020).

According to (Blundell, Lee & Nykvist 2016), personalized learning is another added value to the education sector. Karsenti (2019) describes personalized learning as “AI’s greatest gift to education.”, (p.108). Online learning delivery platforms can personalize learning for each learner by first identifying each student’s academic level and accordingly providing them with the learning material and activities that best fit their capabilities; each student can learn at their own pace at their preferred time and place (Mirra, Morrell & Filipiak 2018). Alhujayri (2018) also indicated that AI-driven digital learning had increased the opportunity of applying a more individualized and personalized education. Considered one of the biggest achievements in AI, adaptive learning ensures that students receive the content most suited to their level. Below a full section is dedicated to elaborate further literature on adaptive learning (Wogu et al. 2019).

2.3.5 Adaptive learning

Implementing AI in education plays a vital and positive role in improving students learning to become more effective and efficient. The Adaptive learning engine is one of the most important features of AI applications that educators can rely on to provide personalized support to students based on their knowledge and need (Lin et al. 2019). Khosravi, Sadiq & Gasevic (2020) illustrate the purpose of adaptive learning systems as providing “an efficient, effective and customized learning experience for students by dynamically adapting learning content to suit their individual abilities or preferences” (P.1).

Kakish & Pollacia (2018) define adaptive learning (AL) as a smart program that provides learners with educational resources that suit the level and needs of each individual learner. This software uses the students' and learners' answers to diagnostic questions and exercises to identify their level and accordingly recommend them the learning content that best suits their capabilities. In their research, Kakish & Pollacia (2018) highlight that the optimal role of adaptive learning is to make students contribute and take part in their learning process rather than just being on the receiving end of it. They also point out the fact that although there is an abundance of software that employs adaptive learning, only a few of them succeed in maintaining the learners' engagement and continue to help them improve their performance.

According to Kakish & Pollacia (2018), if the school and students wish to achieve positive results, it is very important to implement adaptive learning and use the software at hand the right way. Teachers can benefit from adaptive learning by, for example, previewing the results of the activities before starting the next class in order to form an idea of what the students are lacking and plan the class accordingly. This way, adaptive learning programs are considered highly useful for both the learner and the educator in that the learner gets educated on exactly what they need more help with, while the teacher is allowed more time to focus on the concepts that students struggle with the most, (Kakish & Pollacia 2018).

Lin et al. (2019) kick off the teaching cycle with the preparation stage, where students are classified into groups according to their level in the different subjects. The machine generates adaptive learning based on the students' results in previous performances and/or diagnostic tests. Once the machine defines the level of the student, it starts recommending learning material that matches the student's level, style and interests. The teacher also contributes to this stage by advising the students and confirming to them their need for the recommended learning content. Lin et al. (2019) conclude their research by suggesting that the recommendation algorithm the machine uses to provide students with adaptive learning material can leverage the learning efficiency of students, as it saves their time looking for the educational resources that best fit their level. The result of the study Lin et al. (2019) conducted shows that the adaptive resources recommended by AI recommending software are useful for students, especially those with poor performance. Khosravi, Sadiq & Gasevic (2020) found in their study that students using the Adaptive learning system achieved higher results in mathematics than students who did not use the adaptive learning system. However, they claim that there are two main challenges that may limit the development and scaling of the adaptive learning systems; the time experts need to develop the adaptive learning system and the financial cost, where expert's need 25-200 hours to develop learning resources for one hour of instruction only, which makes it expensive to scale. In addition, Khosravi, Sadiq & Gasevic (2020) summarize the learned lessons from their research on applying adaptive learning systems in three main points. Firstly, as the current adaptive learning systems are mostly focused on developing students' basic skills and knowledge, these systems should be enriched with resources that complement students' higher-order thinking, creativity and innovation skills. Secondly, the learning systems send recommended resources based on analyzing students' work and their level in order to close the learning gap; however, it does not enable students to know this data or the logic based on which these recommended resources are sent to them. Therefore, it is advised that these platforms contain data to clarify the logic on which recommended resources are chosen, as well as provide open learning resources to give students the opportunity to choose from several sources. Thirdly, it is necessary to enable teachers to understand their students' data and clarify the rationale upon which the proposed materials are sent to the students, as well as involving teachers in proposing and designing some features that support their students' learning.

2.3.6 Intelligent Classrooms Enhanced by AI

With the advent of technology, more applications are being increasingly integrated into the classrooms; however, teachers should understand how to optimize such applications. A smart or intelligent classroom is essentially composed of an AI-powered learning /platform, computer device, visual and audio devices, and any necessary devices and tools needed to support one-to-one communication and independent learning. AI Scholars are still arguing whether these intelligent/smart classrooms are actually helping improve student learning and increasing their engagement (Wogu et al. 2019).

Figure 2.8 below illustrates a visualization of the researchers and educators' perspective of a smart classroom, where the teacher plays the role of a facilitator and observer while students are learning using the software/platform following their own pace.

Figure 2.8 Twenty-first century classroom (Wogu et al. 2019, p.23)

2.3.7 Intelligent Platform Role versus that of the Teacher

The most beneficial advantage of applying AI technologies in the classroom is taking over the routine tasks, such as grading, lesson planning, assessment activities, recording attendance, etc., which allows teachers more time to spend on focusing on giving students the psychological and behavioural support they need and training them to master the skills needed to keep up with the future job requirements and skills (Wogu et al. 2019).

In the education field, a concern has been emerging amongst teachers that these smart platforms could potentially replace them in the near future, resulting in teachers losing their jobs. (Wogu et al. 2019) argues that smart learning platforms are meant to support teachers and enhance their teaching quality by taking off their shoulders the automated, repeated and time-consuming tasks that are part of a routine teacher practice, which does not require human common sense. There are many areas of teacher roles that a machine can never perform, such as growing values and principles in students to raise them as human beings and getting to know them better, going beyond the limited opportunity allowed in the traditional classrooms, “while part of today’s learning can be by instructions, which is where AI can come in to assist, information based on inspirations, values, love, or educative acts arising from these backdrops, are the kind which no intelligent robot or computer can either accomplish or comprehend” (Wogu et al. 2019, p.29).

2.3.8 Teachers’ Practices with AI-Powered Online Learning System

The main purpose of implementing an AI-powered platform in education is not to replace teachers but to support them by reducing the burden on them and do the routine tasks that take up a lot of their time and effort. For example, collecting and saving students’ data and records, grading students' tasks, analyzing the results, and recommending suitable learning materials to them (Wogu et al. 2019).

Marr (2018) believes that there is great potential for AI in education. If applied smartly, artificial intelligence tools can provide teachers with great support by automating and streamlining the routine and repetitive tasks so that teachers can find time to exercise the tasks that machines cannot perform; that is provide students with personalized learning according to their educational needs. Therefore, according to Marr (2018), while it’s true that AI-powered learning platforms will not fully replace the teacher, they will have a great effect on the teachers’ role and will transform the nature of their task significantly (Marr 2018).

According to Sheridan (2020), the integration of AI in the education sector is on the rise because great strides have been made in personalized learning by utilizing AI technologies, such as chatbots. Such AI-driven tools help identify the students’ and learners’ needs and accordingly support bridge the learning gaps (Sheridan 2020).

Murphy (2019) believes that the current AI-powered educational applications support teachers by addressing some of the main challenges that teachers face and maximizing their capacity to address and overcome these challenges in the classroom. Murphy (2019) pointed to three main areas where teachers face major challenges that AI can help support them with. One of these challenges is having to address mixed student abilities. AI applications can provide immediate feedback to the teachers on students' performance, analyze their work, directly provide differentiated instructions and recommend different resources to each student based on his/her level and work in order to minimize the learning gaps that each student has. AI applications can also help teachers determine struggling students and the areas where they need help so that teachers can intervene and provide some guidance and support. Moreover, such applications allow the students themselves to receive immediate feedback on their work and their writing skills so that they can try harder to improve the quality of their work (Murphy 2019).

Technology has contributed to providing education with different creative ways of teaching and learning. However, teachers now need to change and update their teaching strategies to work with the learning transformation that is happening in the digital world. At the same time, everyone else needs to develop the necessary skills to enable them to use the updated technology (Grand-Clement 2017). "Teachers have to be at the heart of any effort to improve learning, and it's widely accepted that where schools reflect on the quality of their work and plan for how it can be improved, pupils learn better" (Kilternan et al. 2016, p.6).

Aslan et al. (2019) took practical steps to measure the impact of employing a technology that provides teachers with analytical data insights. The aim of such technology is to provide live analytical data on the engagement of the students in the classroom as well as their performance and struggling areas, enabling the teacher to transform their traditional practice into coaching or facilitating practice. Such data helps the teacher identify the students who are disengaged during the class to take action according to the circumstances and encourage them to engage with the learning content. Furthermore, the technology can inform the teacher of the struggling students with comprehensive and in-depth details on the points that the student seems to find difficult, so that the teacher can provide immediate support by further explaining the hard learning material at hand or giving them hints that help struggling students to answer the difficult questions. This enables teachers to better use their time by focusing on the students who need support the most.

The result from the practical study conducted by Aslan et al. (2019) shows that technology made a significant and positive impact on the teachers' practice, which in turn has an impact on students learning by reducing boredom and increasing scaffolding amongst students. Aslan et al. (2019) mentioned that student engagement analytical technology is considered a tool that helps teachers to transform their practice and become coaches or facilitators and relocate their time for better use where it is needed (Aslan et al. 2019). Ritter, S. (2019) supports Aslan et al. (2019) findings as the main goal of using an AI-powered system is to improve the overall educational experience by reducing the lecturing role of the teachers as a mere giver of information and giving them the chance to focus on other areas such as improving the abilities and needs of the students according to the data that the platform provides the teacher with during the class. Eventually, using AI-enabled software will lead to an improved learning environment for both the teacher and the student.

The Importance of Continuous Professional Development

In ideal scenarios, teachers must be prepared to use these AI applications in an effective and efficient way. Thus, teacher training in this area is extremely important. The main purpose of this training is not to lead teachers to be experts in AI but to focus on equipping them for modern and futuristic schools. Karsenti (2019) attributes the significance of training teachers on how to use AI-driven software to the fact that "AI already has a heavy influence on individuals and societies, and we need to develop critical perspectives on AI issues. If teachers are well-trained in using AI technology, it helps prevent technology abuses. Importantly, for AI to make a real contribution to academic success, and for all students, the teacher's role remains as central as ever, perhaps more than ever" (Karsenti 2019 p.111).

AI applications use algorithms to manage and process big data. Therefore, AI applications should not be exclusive to students but should also be utilized to include teachers on the training end and identify their training needs and struggling areas. AI applications can train a huge number of teachers, where they can learn at a suitable time and according to their speed and circumstances. The AI application analyzes the teachers' understanding and provides certificates based on analyzing what they gain from the courses, which is determined by their assessment and task results pertaining to each of the courses. Currently, there are many AI platforms that link tens of thousands of trainees and trainers and contain different learning paths for each trainee (Karsenti 2019).

Iran (2011) conducted a study in Dubai, UAE schools on grades 7-12 students about using technology in Dubai schools. He found that using technology improved teaching and learning; however, both students and teachers need to develop their skills of using technology. Professional development training is required, especially when processing or implementing new technology tools. According to McLoughlin and Northcote (2017), Mezirow's Transformative learning theory presents the new role of the teacher and explains how the teacher's role is different from digital and digital learning from traditional teaching and learning. Educators required rethinking in teachers' professional development and practice because the role of teachers has changed with digital learning. The teacher role as a facilitator means they should be able to rethink and identify their role and skills and pedagogy required to adopt digital learning.

Teachers should have the opportunities to develop their skills through supportive professional development (McLoughlin & Northcote 2017). According to Baker, Gowda and Salamin (2018), the Alef digital education system provides real-time data for teachers about students' work, which supports teachers to manage their classroom with full pictures about the levels of students' skills, they can do remediation if necessary. Alef Education Company also provides experiential learning kits for teachers to support them with hand-on activities to link information with students' real life. Tempelaar et al. (2015) suggest that teachers should be able to catch and train students in the skills of other learning styles. Sulisworo and Toifur (2016) suggest that the teacher role is changing with digital learning. Teachers who use technology with clear objectives and based on learning outcomes that support 21st learning skills (research, critical thinking, creativity, collaboration) experience active learning. On the other hand, teachers who are passively teaching (assigning and sitting) without facilitating experience are more passive learning. Teachers with digital activities must be engaging in order to elicit engaging behaviours because times are changing, and learning is changing as well (Sulisworo & Toifur, 2016). Due to the impact of technology on education, integrating digital learning in schools becomes an inevitable option, and it should be implemented as a primer learning resource and daily education process (Al-Gumaei et al. 2019). Al-Gumaei et al. (2019) find that there is a positive relationship between effective usage of technology as the hardware and software in the classroom and improving the teaching and learning processes.

Al Gamdi (2015) conducted research aimed to find the impact of continuous professional development that was provided to teachers on how to use and implement ICT in their classrooms. The research goal was to investigate how continuous teachers' professional development in ICT influences teachers' behaviour in the classroom and their attitudes toward using ICT and improves their knowledge. The research result was mixed: this continuous training had a positive impact on some teachers, and it had improved their behaviour and knowledge in implementing ICT in their classroom, and they changed their teaching style. However, there are many other teachers who were not impacted by this training material, and their teaching style stayed as is (Al Ghamdi 2015).

Pettersson (2018) suggests that digital competence is a school responsibility, every school should apply a holistic approach to improve the implementation of ICT, and digital competence should not be the teacher's responsibility. Schools should not depend on teachers only to improve digital competence in the schools; instead, digital proficiency should be included in school improvement strategies and plans, and it should be considered as a whole school duty (Pettersson 2018).

Alzahrani (2016) conducted research in Saudi Arabian schools to explore teachers' perspective toward implementing digital technology in their e-learning in secondary school and also to investigate the impact of teachers' professional development on teacher practices in the classroom. Research results show that teacher training and professional development has an effective role in teaching. He emphasizes that the training provided to teachers on how to implement digital learning in their classrooms and on the benefits of digital learning to both teachers and students has a positive influence on teacher attitudes and perspective toward digital learning and on their practice in the classroom. Alzahrani (2016) mentioned in his research that most of the teachers included in his study highlighted that the learning management systems that they used helped them to change their roles from traditional teachers into facilitators and to apply a modern method of teaching and learning in their classrooms. However, some of the teachers pointed out that such management systems didn't pose any change related to their teaching style, yet they agreed that the learning management system had been helpful.

Last but not least, Hsu (2016) believes that for successful usage of computers and technology, there are conditions that should be fulfilled, such as convenient and easy access for teachers to the technology, teachers should have enough time and room in the curriculum to use this technology, teachers should be trained and well-disposed to use this technology, and teachers should internally believe in the possibilities and benefits that using this technology creates for the students.

2.3.9 The Impact of COVID–19 on Education

Due to the spread of the COVID-19 pandemic, 191 countries around the world were forced to close down their schools as a measure to prevent the spread of the virus. According to Erfurt & Ridge (2020), this is the first time in history this number of schools is affected at the same time. Educators worked hard and fast to find a way to ensure that students continue learning despite the situation. Data shows that before the spread of the pandemic, digital platforms were used in schools that are more high-income, while most low-income schools were using traditional teaching methods. Besides the access to a digital learning platform, many of the students coming from low-income families lack the availability of a quiet and isolated space to focus on learning and the devices and internet access needed to access the digital platform. Additionally, Erfuth & Ridge (2020) pointed out that the pandemic has an indirect negative impact on such students due to the financial and economic implications, social isolation and health concerns that, although are not conclusively manageable, have one way or another affected student learning.

As per the official website of the United Nations Educational, Scientific and Cultural Organization, widely recognized as UNESCO, most countries have resorted to distance learning and education as a way to avoid interruption of education, each within its capabilities. Some countries uploaded the learning content digital on official websites, but that doesn't necessarily include full-fledged digital learning. According to UNESCO's website, the success of digital and distance learning in each country depends on the adoption rate of digital platforms in the schools of these countries before the pandemic. The higher the adoption rate, the more prepared the schools, students, teachers and parents are to adapt to the situation and make the best of it. Additionally, many countries are also not able to guarantee that learners and employees working in the education sector who are with disabilities have access to digital educational platforms and services. UNESCO pointed out that although digital educational content has been made available, in some cases for free, the main task that needs to be the focus of countries to make the continuity of learning a success is to put policies and strategies in place to ensure that all students, of all income-levels, categories, regions and age groups have the necessary connectivity to be able to access this digital content. Furthermore, in a more advanced and later stage, countries should be able to put an organized structure that helps guide schools and teachers to the right path of education amidst such conditions.

According to Cahapay (2020), education post the COVID-19 pandemic will not be the same and that using technology in the classroom will be the new normal. Once the situation goes back to normal and schools re-open, students will have gotten used to depending on technology in learning, and they will still use technology to learn independently and on par with school education. Predictions indicate that the way students learn and the way teachers deliver the learning material will no longer be the same (Cahapay 2020). Cahapay (2020) also claim that “the coming new normal post-COVID-19 era can be a teachable moment for content that is significant, relevant, and useful” (P.2). However, countries need to make sure comprehensive plans are designed to ensure that all students are equally included in the “new normal” in education (Dabbous et al. 2020).

Although teachers were sceptical that distance learning could actually succeed, many have proposed new methods of using technology in education that they can build on what they have experienced during the lockdown to improve student learning even after schools are reopened. Tria (2020) suggests that “there is a need to strengthen policy in terms of the delivery of instruction - to provide opportunities for online learning platforms” (P.2).

There are a few of the benefits as stated by Dabbous et al. (2020), such as well-preparedness for better intervention: teachers now can think of many creative ways to help close the knowledge gaps their students have by, for example, pre-recording videos that their students can watch anywhere and at any time. Absence from school no longer means interrupted learning: teachers can always record their classes and send them to students who are absent for any reason to watch the videos and keep up with their colleagues. Allowing teachers to change the pace to specific groups of students according to their level enables them to provide their students with pre-recorded videos that explain the main concept of the lesson, which in turn allows the students to re-play these videos as many times as they like, while the teacher has the opportunity to walk around the class and check on the students. Getting feedback from parents, other teacher colleagues and from students: Teachers should be more open to the idea of getting assessed by students and parents.

This opens the door to a meaningful and highly beneficial dialogue between the teachers and parents (Dabbous et al. 2020).

Dawadi, Ashish Giri and Simkhada (2020) investigated the influence of the outbreak of COVID-19 on the education system, particularly the schools of Nepal. Their work analyzes and reflects on the "opportunities and challenges the pandemic has presented for the technologization of the education system" (P.1). The results show that the closure of schools has had major consequences on underprivileged students and that it made the gap between them and privileged students even wider when it comes to accessing a rich digital education. The study also shows how, although Nepal started implementing ICT in education in 2000, the spread of COVID-19 still posed many challenges due to the "faulty implementation strategies".

Dawadi, Ashish Giri & Simkhada (2020) uphold UNESCO's findings with respect to the educational preparation of various countries to face the consequences of the pandemic. The response to the pandemic varied from one country to the other. For example, the countries that were already equipped with advanced technology could adapt faster by implementing distance learning along with making developments to their digital learning platforms, such as Moodle, Learning Management Systems (LMS), and their cloud systems. They also made access to digital learning and educational resources available to the students via tablets and mobile devices. Another example they mention in their study is China and India, which created a "national repository" for all students across the country to access and continue learning from. China took the extra mile to cover emotional support by providing students with psychological support during this period.

To study the impact of the pandemic on the students themselves and as per results collected from surveys of around 230 school students after the schools' lockdown was enforced, students showed more concern about school grades and inquired more about how schools will manage giving and marking tests. The students were more stressed and confused about the academic aspect than they were about having to be socially distant from their colleagues and teachers (Dabbous et al. 2020).

In an attempt to reach an understanding of how the spread of the COVID-19 virus and the closure of schools has affected the perspectives of teachers, and more importantly, parents, Dabbous et al. (2020) surveyed almost one thousand parents and five hundred teachers from across the UK. The main conclusion they arrived at from the responses collected from parents is that now that parents are more involved in the education of their children, they have grown to become more aware of the type of work that teachers and educators do on a daily basis. The results also showed that female parents have become more appreciative of the teachers' work than before the closure of schools. Some parents indicated that the outbreak of the virus and the schools' lockdown that ensued made them reconsider the career paths they were hoping their children will pursue in the future. This means that the pandemic, besides all the obvious and direct effects, may give more importance to sectors that previous to the virus outbreak were not given the same value. The survey results also showed that both teachers and parents believe that education post the pandemic should change: teachers now have a more positive attitude towards digital learning and using technological tools; older teachers also expressed their willingness to continue to use digital tools in education after everything goes back to normal. (Dabbous et al. 2020)

2.3.9.1 The UAE's Ministry of Education Response to COVID-19

The response of the United Arab Emirates to the COVID-19 pandemic was similar to other countries, where the ministry of education announced the closure of schools by the beginning of March 2020. However, the UAE's Ministry of Education also announced that distance learning would be implemented in both public and private schools (Erfurth & Ridge 2020). This news was circulated through the local newspapers and media as well as on the Ministry of Education's official website and social media platforms. Erfurth and Ridge (2020) presented all actions from the ministry of education regarding their responses as follows; guidelines and policies were provided by the Ministry of Education on how distance learning will be implemented, covering expected students' behaviour towards digital learning and virtual class. All students in public schools and many students in private schools were given laptops from the UAE government; some of the students who do not have internet services were also provided with internet packages for free. The Alef Platform was offered for free for all students in private and public schools. Alef Education Company also offered free tablet devices to students in low-income private schools. The UAE Ministry of Education evaluated distance learning in all private and public schools and sent surveys to school leaders, teachers and parents. At the end of the school year, all students in public schools took their centralized exams remotely and then all students' results were published. The UAE's Ministry of Education considered different scenarios for the next school year 2020/2021: depending on the COVID-19 situations, it could be distance learning only or blended between distance learning and in schools (Erfurth & Ridge 2020).

Erfurth and Ridge (2020) in the Al Qasimi Foundation conducted a study in April 2020 that aimed to understand the perspective of teachers, school leaders and parents regarding distance learning in the UAE public and private schools. This study focused on four main areas within distance learning: first is the preparation for the implementation of distance learning by teachers, school staff and students and how they were getting training on the implementation of digital learning; the second is the workload on school leaders, administrative staff, teachers, students and parents during distance learning; the third is the challenges that working parents face, especially those who have to work in their workplace or outside their houses such as doctors, hospital staff and police; and the fourth is students with special needs who require a lot of support from their specialists and/or their teachers (Erfurth & Ridge 2020).

The main finding from Erfurth and Ridge (2020) is that, firstly, approximately all parties received a little bit of distance training as a preparation for distance learning; however, they were satisfied with this training, and they felt it is enough to be able to implement this kind of learning. Secondly, most school leaders and teachers agreed that the workload with distance learning during COVID-19 becomes more stressful and needs a lot of preparation before class time starts. Working parents who have school students learning remotely from home fell in a very critical and stressful situation, their work becomes double in the amount as they have to do their regular job and they have to teach, observe and take care of their kids, and if parents work outside their house as a doctor for example, then the level of stress becomes very high. The final finding is about students with special needs; the study pointed out that those students had very limited support during the distance learning and their parents were concerned about them with the limitation of support provided to them (Erfurth & Ridge 2020).

2.3.9.2 Lessons Learned from the COVID-19 Pandemic

In UNESCO’s Synthesis Report (2020) which covers the actions, challenges and strategies that different ministries from around the world faced after the outbreak of the pandemic. The report starts by mentioning the major challenges that ministries of education face and what lessons those challenges should teach the decision-makers in the education sector.

Most countries around the world were not prepared to provide all students with access to digital learning platforms. Many of these countries do not have a strongly built educational infrastructure that enables them to implement distance learning during crises and pandemics. According to (Drane, Vernon & O’Shea 2021), in Australia, the closure of schools around the country disrupted the education of millions of students. In China as well, the education system fully transformed from face-to-face learning into online learning post-COVID, where 92% of students received their education via online platforms (Dong, Cao & Li 2020). As per (Rasmitadila et al. 2020), in Indonesia, various methods are used to ensure education continuity around the country; these methods include online learning applications, TV channels and radio channels; in addition, offline methods are used as well, such as books and printed material. Students and employees in the education sector do not have equal access to the internet to be able to manage the continuity of learning in such circumstances. When most of the countries flipped to distance learning, most of the teachers in these countries received the new changes as a shock. They did not have the flexibility to adapt to remote and distance learning (UNESCO’s Synthesis Report 2020).

According to UNESCO's report (2020), although this kind of impact on education is the first of its kind, countries should make the best out of it and create a flexible educational system. The main lessons that the report advises ministries of education to do are:

Establishing a strong Information Technology foundation is key to prepare students and equip them to learn remotely. Where each country stands today in terms of succeeding in saving its students' education correlates with how adoptive it is of technology in education. Drane, Vernon & O’Shea (2021) suggests that all countries should thoroughly test the education system’s readiness to ensure that learning continues amidst any kind of crisis. It is also advised that a hybrid education system is applied, where students can learn online and in person at schools by facilitating a unified platform, as opposed to having a multitude of platforms, which can cause confusion for students and teachers; this way in the event of any school closure, students and teachers can seamlessly manage to transfer to a fully online learning mode, (Drane, Vernon & O’Shea 2021).

Training teachers to use technology is highly important for a successful implementation of online learning. If teachers are not well-prepared and well-acquainted with technological tools, it will be almost useless and highly challenging for both teachers and students to successfully utilize the available digital and digital resources (Rasmitadila et al. 2020)

Based on UNESCO’s Synthesis Report (2020), just like all other aspects of education, assessment should also change. New and more innovative methods should be implemented for an enhanced evaluation of students’ performance.

Now is the time for countries to start thinking ahead about education and lead the transformation of education from traditional to digital. After the pandemic is over and once schools reopen, education will not entirely go back to where it was before the pandemic. Ministries of education should be well-disposed for that (Dong, Cao & Li 2020; Drane, Vernon & O’Shea 2021). With the constant development of educational technology comes major players in the market that could well help improve the education sector. Therefore, countries should also start thinking of establishing strategic partnerships with these market players (UNESCO's Synthesis Report 2020; Rasmitadila et al. 2020)

Educational and instructional theories and methods that are taught and applied across schools should also be updated. While some theories and philosophies in education are considered highly valuable and fundamental to the improvement of education, the new and fast technological development calls for new theories and methodologies to be put in place in order to stay abreast of the new market requirements (UNESCO's Synthesis Report 2020).

Besides the above-mentioned tips, the UNESCO's report (2020) also proposed five main points to consider for a successful future education; the first point is working on the development of Contextualized Multiple Intelligences, more likely to be known as CMI, to be able to keep up with the new changes taking place in the different aspects of life, such as the economic, social, technological, political, cultural, and educational aspects. The second point the report point out to is converting from the physically-bound traditional learning into multimedia intelligent material where the focus lies on individualization (i.e. growing the individual's creativity and potential), localization (i.e. using local and culturally relative learning resources with the support of a known learning community) and globalization (i.e. getting to connect with learners and mentors from different areas around the world and to learn from global educational resources). The third point is utilizing technology and artificial intelligence to transform education. AI provides a wide room for creating new opportunities and innovations that will reshape education and learning as we know it today. The fourth point mentioned in the report is creating interactive educational systems as new and interactive artificial intelligence techniques can be built to create an interactive digital learning environment for students that goes beyond digitizing traditional books into electronic scripts. The final point mentioned in the report is reshaping education and preparing it for various disruptions that could befall it in the future.

In addition, UNESCO's report (2020) included a number of opportunities that the pandemic presented to the education system. For example, due to the outbreak of the pandemic and the closure of schools, governments and educational ministries are working hard to integrate technology into education. Digital and AI-powered learning platforms are also being developed with bigger ideas and ambitions and not only as tools that support school education. Additionally, personalization and individualization in education will soon reach full potential as more work is being currently done on differentiation in education.

Lastly, UNESCO’s report (2020) forecasts a number of changes that are expected to take place in the near future. New policies and laws will be enacted to regulate technological learning platforms to achieve a seamless and organized transition into digital education. Moreover, physically bound education and schooling will be changed. The report poses the question of what the fate of traditional education will become. It is also expected that the digital education market will be valued at 350 billion dollars by the year 2025, as continuous education that is not governed by geography becomes the new normal for education.

2.3.10 Conclusion

In this chapter of the thesis, the researcher presented four main components that are related to the thesis topic - How AI-Powered Online Educational Platforms Drive and Improve Student Learning and Teacher Practice in Abu Dhabi Schools. At the beginning of the chapter, the researcher went over the history of AI and how it developed and explained the main concepts of AI in relation to learning and teaching and how it helps enhance teaching and learning. Then this chapter showed the theoretical framework and discussed all related theories, as well as the conceptual framework, which presented the principles that stand behind successful implementation of digital learning.

This chapter also mentioned the literature review of the previously published studies on digital learning and its effect on student learning and how AI-driven digital platforms contributed to the development of teaching and learning in the classroom. In addition, the chapter also touched upon the role of digital learning during the COVID-19 pandemic and how it helped education continue even amidst world-wide school closure.

CHAPTER 3:

RESEARCH METHODOLOGY

3.0 Introduction

This chapter illustrates the research methodology used to understand and address the research questions. It describes the approach taken in this research, gives a rational explanation of the research design and illustrates the stages followed to design the study and address the research questions. The thesis of this research is “How AI-powered digital educational platforms drive and improve student learning and teacher practice in Abu Dhabi secondary schools”. In other words, this research seeks to find out how AI-enabled platforms that utilize technology to offer personalization and differentiation amongst learners affect teaching, learning and student outcomes.

To arrive at a comprehensive answer to this thesis, the researcher identified four core questions to cover the three main areas involved: namely, students, teachers and distance learning during COVID-19.

1. How does AI-driven digital learning improve students’ learning?
2. To what extent does digital learning impact students' engagement?
3. What are the teachers’ perceptions of AI-powered digital learning platforms?
4. How does the implementation of AI in digital learning impact teachers’ practice?
5. How do AI-powered digital learning platforms help students and teachers during Coronavirus (COVID-19) pandemic?

3.1 Research Approach

Any research should apply one of three research approaches, the quantitative method, the qualitative or the mixed-method approach. As Bryman and Bell (2011) emphasized the strengths and weaknesses of both the quantitative and qualitative research methods, a mixture of both methods was proposed to avoid these weaknesses (Bryman & Bell 2011).

According to Hammarberge, Kirkman & de Lacey (2016), qualitative methodologies are conducted to capture what the measurable data cannot. The main aim of using qualitative methods is to have a better understanding of the participants' experience from his/her own point of view. The outcomes of qualitative research methods are mostly unmeasurable and uncountable. Some of the techniques that are used to conduct qualitative research are: holding discussions amongst groups to further look into the general opinions and attitudes of "normative behaviour"; conducting 'semi-structured interviews' where the researcher focuses on a specific topic in their discussion with the participants; conducting 'in-depth interviews' to try to understand the individual experience of each participant from their personal standpoint; and analyzing documents associated with the topic in hand to cover the available knowledge, whether public or private, (Hammarberg, Kirkman & de Lacey 2016).

The quantitative method is described as that which "entails the collection of numerical data and as exhibiting a view of the relationship between theory and research as deductive, a predilection for a natural science approach and as having an objectivism conception of social reality" (Bryman & Bell 2011, p.150). Qualitative data can be collected from closed-ended questions where the answer to each question is limited to specific answers that the respondent can choose from, which means that the answer can be measured, and based on that, the relationship studies can be quantified.

3.1.1 Mixed Method Approach

The mixed-method was first formally used in 1980, and then a growing number of researchers started to implement it (McKim 2016). Additional time and effort are required to be added from researchers to apply the mixed-method study, which is why it should add value to the study. Researchers should be aware of the perceived value of combining two methods before making a decision to employ it; if applying the method does not add value, researchers should be content with one proper method (McKim 2016). According to Molina-Azorin (2016), the mixed-method approach is considered an opportunity to develop research fields because it adds value and depth of knowledge to the research field.

The mixed-method approach is employed in this thesis to conduct a comparison combining quantitative and qualitative methods. The reason behind the researcher's decision to use a mixed-method approach, is that the quantitative data is necessary to provide a fact in all study areas while qualitative data is very important to add a big value to the study because in this field, teachers form an important factor. The researcher needs to hear from the teachers to be able to know further about the teachers' perspective on the implementation of the Alef Platform and to get an understanding of the challenges that they face using it. The current thesis focuses on four main areas: students' performance, students' engagement, teachers' practice, and the impact of the platform in applying distance learning during COVID-19.

Collecting and analyzing quantitative and qualitative data in the mixed method approach could be concurrent or sequential, based on the priority and the integration of the data at one or more steps in the research process (W. Creswell, V. Ivankova, & D. Fetters 2004). This thesis follows the concurrent approach, where quantitative and qualitative data are collected at the same time and are brought together in the results and interpretation of the results to gain a deeper understanding of the research questions. Both methods share equal priority; there is no priority for one method above the other as both quantitative and qualitative data are primary data, and one type of data doesn't impact the other types as each survey's different aspects. Quantitative data focuses on students, and qualitative data mainly focuses on the teachers; using both methods helped to get the advantages out of both methods.

3.2 Research design

In this thesis, the researcher examines the relationship between implementing an AI-powered platform that provides a personalized learning experience and students' motivation, learning outcomes and teachers' practice through a case study of implementing an AI-enabled digital learning platform in 12 secondary public schools in Abu Dhabi emirate in the United Arab Emirates.

The researcher draws on longitudinal data of full two-year implementation in 12 secondary schools, including the daily formative and summative assessment scores taken during and at the end of each lesson, the time spent on the Alef Platform, the number of completed lessons on the Alef Platform, the diagnostic test results taken in two different periods, and the official national centric exams by the UAE Ministry of Education for the 1st term of the academic years 2019/2020. In addition, the researcher conducted a survey for teachers in these 12 schools to dig deeper into their perspective on the AI-driven Alef Platform.

The Alef Platform has an automated algorithm where customized daily practices for each student are provided in order to maximize each student's progress towards mastery of the UAE Ministry of Education’s curriculum. The platform also provides digital content that is aligned with the national MOE curriculum. Each lesson on the platform ends with an assessment activity known as “summative assessment”, which is automatically graded and updated to support each student with personalized practices that cover his/her missing skills.

3.2.1 Site, population and participant selection

This thesis focuses on Abu Dhabi secondary schools in the United Arab Emirates, including a population of 12 schools, 7,039 students and 600 teachers. The Ministry of Education in 2019/2020 implemented a new AI-powered digital learning platform, Alef, in 151 public schools in Abu Dhabi. The implementation of this platform started with one school in 2017/2018; then, school numbers increased to 10 public schools in 2018. In 2019, the number of schools that implemented the Alef Platform started at 57 schools in January and ended at 151 schools in September 2019.

This study is conducted in all of the 12 schools, which have 7,039 students from different grades (grades 6, 7, and 8). These schools are geographically distributed in different regions - Abu Dhabi, Al Ain and Western Region (Al Dhafra). Approximately 7,039 students in all the 12 schools participate in this study, and around 600 teachers and school administrators.

The researcher divides them into two groups of 6 schools, where one group started implementing the Alef Platform in September 2018, while the other group composes schools that started using the platform in September 2019. Those two groups are then divided into equal subgroups of male and female schools. These groups help the researcher to investigate how AI-powered digital learning improves student learning and engagement by comparing the results of average summative assessment, the centric exams conducted by the UAE Ministry of Education and diagnostic tests conducted by a specialized company as a third party requested from ADEK throughout the 2019/2020 academic year. This research also covers the teachers' performance and how it is impacted by AI-powered platforms.

Six of the schools, three boys' schools and three girls' schools, started implementing the Alef Platform in September 2018. The other six schools, similarly, three boys' schools and three girls' schools, started the implementation of the Alef Platform in September 2019. The purpose of drawing the comparison between those two groups is to learn if students who have used the platform for a longer period of time gained better learning outcomes, which can be deduced from the students' results in several standardized assessments and tests. Those results are taken from the same tests and assessments that the two groups of schools take at the same time of the academic year, specifically, October 2019 for the diagnostic tests and December 2019 for the MoE centric exams. As for the third instrument, the Summative Assessment activities on the Alef Platform, the results are collected over the whole academic year 2019/2020.

The table below summarizes the research questions, research approach, instruments used to collect data for the research questions, participants and data analysis.

Table 3 1 Research Design

Research question	Instrument used	Targeted population	Data reliability and validity	Data analysis

1. How does AI-driven digital learning improve students' learning?	Summative assessment Time spent on the Alef Platform MOE final exam results Diagnostic tests Teachers' survey	7,000 students 600 teachers	Pearson and Spearman The Mann-Whitney U test Cronbach's alpha	Quantitative using: Jupyter Notebook SPSS SurveyMonkey Qualitative using: Coding in SPSS
2.What are the teachers' perceptions towards AI-powered digital learning platforms?	Open-ended question through Teacher survey	600 teachers		
3. How does the implementation of AI in digital learning impact teachers' practice?	Teachers' practice and activity on the Alef Platform Teachers' Survey	600 teachers		

5. How do AI-powered digital learning platforms help students and teachers during Coronavirus (COVID-19) pandemic?	Time spent on the Alef Platform No. of Completed Alef lessons Teachers' survey	600 teachers 7,039 students		

The researcher created a number of sub-questions for the core questions mentioned in the above table, where required, to explore a more detailed design and to link each sub-question with the approach to data collection.

1.1 Is there a relationship between the total time spent on the Alef Platform and the final concept mastery?

1.2 Is there a relationship between the final score on the Alef Platform and the final scores in the Ministry of Education's exams?

1.3 Is there a relationship between the total time spent on the Alef Platform and the final scores achieved in the MOE centric exam?

1.4 Is there a difference in the MOE's final exam results between students attending the group of schools that implemented the Alef Platform in 2018 and the students attending the schools that started implementing the platform in 2019?

1.5 Is there a difference in the average summative assessment score between the students attending the group of schools that implemented the Alef Platform in 2018 and the students attending the schools that started implementing the platform in 2019?

1.6 Is there a difference in the diagnostic test score between students attending the group of schools that implemented the Alef Platform in 2018 and the students attending the schools that started implementing the platform in 2019?

1.7 What is the teachers' perspective toward the role of the Alef Platform in improving student learning?

1.8 Is there a relationship between the Total Time Spent on each stage of the Alef Platform lessons and the formative assessment score?

1.9 Is there a difference in the average time spent on the Alef Platform between students attending the group of schools that implemented the Alef Platform in 2018 and the students attending the schools that started implementing the platform in 2019?

1.10 What is the teachers' perspective about the impact of the Alef Platform on students' engagement with learning?

3.1 Is there a difference in the Alef Platform usage between teachers in group 2018 schools and teachers in group 2019 schools?

3.2 What is the teachers' perspective about the impact of the Alef platform on transferring teachers' role from constructing to facilitating or coaching?

3.3 Do teachers believe that the Alef Platform saves their time and reduces their workload?

4.1 Is there a difference in the average time spent on the Alef Platform before and during the COVID-19 situation?

4.2 Is there a difference on the average number of completed lessons on the Alef Platform before and during COVID-19?

4.3 Do teachers believe that the Alef Platform supports them and their students during the COVID-19 situation?

3.3 Research Instruments to be used and Targeted Groups

This research covers both students and teachers and uses various types of instruments to collect data for each group of stakeholders. In this section, the researcher illustrates all instruments used and how they show performance, engagement, and progress for the students' part as well as the teacher's practice. Additionally, the researcher elaborates on the reliability and validity of each instrument that is used in this thesis as these two factors are important measurement tools and fundamental features for the evaluation of a qualified study. According to Mohajan (2017), "validity is concerned with what an instrument measure, and how well it does so. Reliability means the faith that one can have in the data obtained from the use of an instrument, that is, the degree to which any measuring tool controls for random error" (Mohajan 2017 p.1).

3.3.1 Data Collection Instruments for Students

This section presents all the instruments used to collect data related to students' performance, progress and motivation. The researcher collects the primary data from the Ministry of Education, Department of Education and Knowledge, and Alef Education for the purpose of analyzing this data and answering the research questions.

The students’ results in the MOE centric exams were received in 6 different Excel Sheets, each sheet representing the results of one of the six core subjects, classifying the data into three columns: schools’ IDs, students ID and grade.

As for the diagnostic test results, the researcher received 4 Excel Sheets that each included the students results in one of the four subjects that were tested, namely, math, science, English and Reading. The results were presented in three columns: schools’ IDs, students’ IDs and test results.

Finally, the researcher received the students’ data on their activity on the Alef Platform in the form of one comprehensive Excel Sheet containing the average in all subjects for these columns: school ID, student ID, number of completed lessons, the average of summative assessment, the average of formative assessment, average time spent in each stage.

The researcher conducted the necessary analysis of the data acquired from the above-mentioned sources as specified in the Data Analysis section below. The rationale behind using three different sources of data is to present strong evidence and proof of the authenticity and accuracy of the research results. Depending on three different sources limits the probability of error in the results.

3.3.1.1 Diagnostic Tests

Alef Education runs two well-known international diagnostic tests for four core subjects: English, English Reading, science and math. To assess and diagnose students’ level in English and Science, the NEWS MAP growth tests are used. These tests are considered the “most trusted and innovative assessment tool” (MAP Growth 2020 P.1) to measure students’ level and the progress they make in the areas of math, reading, language and science in K-12. These tests support teachers by providing them with accurate data that they can use to take practical steps towards addressing individual students, or groups of students with similar needs, as per their learning needs, regardless of the gap (whether positive or negative) between their level and that of their peers. In addition, NEWS MAPS tests create a network that includes the major providers of learning content, which in turn allows educators more flexibility in choosing the curriculum (MAP Growth 2020, p.1).

Renaissance Star Math Diagnostic test is used to assess students' math skills. This test shows the teachers which students are struggling with math and what specific areas they struggle with so that the teacher can work with the students to bridge these learning gaps and strengthen the skills they lack (Star Math/Renaissance 2020, p.1).

Such tests are digital adaptive test, meaning that each student would automatically receive a question to be answered based on his/her performance in a previous test item. These companies develop a pool of questions in the backend, which is their business model. Therefore, Alef Education, as a test subscriber, only has access to test use and test results, but not the test questions. These tests are conducted on a regular basis (twice during the academic year) to help track the baseline versus the actual grade level performance of students in each subject. The results of these diagnostic tests represent a track record of the student's progress over the year. The results of such tests are taken into consideration because there is no conflict of interest with Alef Education or the Ministry of Education, which gives this instrument high validity and reliability.

All of the 12 schools that are included in the research sample took the same diagnostic tests in October 2019. The comparison the research makes is between the six schools that had two years of experience using the Alef Platform and the remaining six schools that had just started implementing the platform.

The researcher collects huge amounts of data on the diagnostic test scores for a total of 7,039 students in the format of an Excel spreadsheet that includes each of the 12 school IDs, students' IDs in each of the included schools and their scores in Mathematics, Science, English and English Reading. The researcher then proceeds to analyze this data to answer the research questions.

3.3.1.2 MOE Centric Exams

In the UAE, the Ministry of Education conducts a centric exam twice a year for all core subjects; all students in public schools must take these exams to be able to move up to the next grade. These exams are conducted twice a year, at the end of Term 1 around December, before the mid-year break begins, and the other round at the end of Term 3 - during the month of June, which marks the end of year exams. MOE centric exams are organized and written by the Evaluation Center Office in the MOE. In order to track students' progress, the researcher compares students' results in the MOE centric exam in different schools for boys and girls and at different periods of times. For example, the researcher compares the results of these exams between the six schools that started implementing digital learning (the Alef Platform) in 2018 and the other six schools that started Alef implementation in 2019. The purpose of this step is to investigate if there is a difference in the result. Furthermore, the researcher makes a comparison between students' results in the MOE centric exams and the summative assessments taken on the Alef Platform. MOE centric tests are conducted across all public schools in the United Arab Emirates. These tests hold strong validity and reliability as they are the tool that the Ministry uses to measure the level of knowledge the students have and to track their progress over the years.

The researcher collects the scores of 7,039 students in the MOE centric exams as primary data in the format of an Excel spreadsheet that includes each of the 12 school IDs, students' IDs in each of the included schools and their scores in the six core subjects, namely, Mathematics, Science, English, Arabic, Islamic Studies and Social Studies. The researcher calculates the average that each student achieves in all six subjects put together, then proceeds to analyze this data to answer the research questions.

3.3.1.3 Alef Platform Data

The Alef Platform employs a system that encourages the students to perform formative and summative assessments on a daily basis. During the learning process, live data is collected while the student is learning in the class. The Alef Platform has activities at the end of each lesson to assess and measure the daily progress each student makes. According to Melzer (2019), analyzing students' formative and summative assessment grades is the best way to reflect their learning outcomes and measure the whole learning intervention. The Alef Platform collects data continuously as it captures any activity the student makes on the platform, even if the student uses the platform after school hours. By the second, this data is being collected using a machine and through no human interaction whatsoever. This gives the data collected full credibility and ensures there is no bias towards the results of students' performance. In addition, the Alef Platform collects millions of points of live data on different levels: the student level where data is collected for each student's formative and summative assessments in each lesson and each subject over the year and also compare how students perform in different subjects; on the class level, presenting an overview about the performance of all students in each class in formative and summative assessments in each lesson and also making a comparison between different classes; the lesson level to illustrate how many students complete each lesson and how they perform in it. It also tracks other key behaviours on the platform, such as the time spent on each part of the student skips any part of the content.

The researcher collects the data showing the primary data on the performance of 7,039 students over the full academic year in the formative and summative assessments on the Alef Platform in the format of an Excel spreadsheet that includes each of the 12 school IDs, students' IDs in each of the included schools and their scores in the formative and summative assessments, number of lessons completed, average time spent on the platform, in the six core subjects, namely, Mathematics, Science, English, Arabic, Islamic Studies and Social Studies. The researcher then proceeds to analyze the data to answer the research questions.

The research uses this data to answer the questions posed on the impact of digital learning on the students' performance, motivation and engagement. The researcher collects the data for all students from 12 public schools and then compares the results from the six schools that started to use the Alef Platform in 2018 with the results of the six schools that started to use the Alef Platform in 2019. The researcher also compares the students' results in MOE exams at the end of the first term over the 2019/2020 academic years. The researcher then draws a further comparison between these results and the students' average daily work on the platform as well as the results of the diagnostic tests. The data shows the difference between the students' MOE exam results, their average score in their daily work using the data saved on the Alef Platform and the diagnostic test results. This provides more validity to the research finding as the researcher uses three different pools of data: The Alef Platform data, MOE exam results and diagnostic test results, which are created by third party companies.

3.3.2 Data Collection Instruments for Teachers

3.3.2.1 Alef Platform Data

The Alef Platform tracks not only the student's progress and usage but also covers the teacher. The platform tracks the teacher's activity on the platform as well as how much the teacher can utilize the use of the platform during the class. This also helps measure the impact of the platform on the teachers' practice. The Alef Platform tracks the teachers' activity on the platform and in the process, collects data on the teachers' usage of the platform. The main purpose of collecting data on the teacher is to provide a comprehensive understanding and to try to compare the relationship between the students and teachers' usage of the platform. The data collected on the activity of the teacher is just as valid as the data that captures the student activity.

In this study, the data collected on the platform usage by the teacher helps to understand if there is any relationship between teachers' usage of the Alef Platform and students' performance. Hence, the researcher compares teachers' activity on the platform and the students' performance in formative and summative assessments on the platform.

3.3.2.2 Teachers Survey

Teacher surveys conducted with (600) teachers from the twelve schools that implemented the Alef Platform. The survey was a mixture of closed-ended and open-ended questionnaires, which provides a more comprehensive set of results. According to Zohrabi (2013), "it is better that a questionnaire includes both closed-ended and open-ended questions to complement each other" (Zohrabi 2013, P.255). The teacher' survey was sent to the teacher digitally using the paid subscription on SurveyMonkey to the teachers who were using the Alef Platform, asking them about their experience with the Alef Platform and their perspective toward it. Then the teacher sent their response automatically through SurveyMonkey without knowing their name or school, which helps with a transparent and clear description from the participants. According to Noble and Smith (2015), this approach increases the data validity and reliability because all responses are received from the participants automatically without any input from the researcher, which assure there is no bias, also helps to “ ensure sufficient depth and relevance of data collection and analysis” (Noble & Smith 2015, p.2) which is one strategy for increase qualitative research validity and reliability (Noble & Smith 2015) and also helps also to implement another strategy to increase qualitative research validity “meticulous record-keeping, demonstrating a clear decision trail and ensuring interpretations of data are consistent and transparent” (P.2). This approach helps to ensure different perspectives are represented with a variety of teachers’ descriptions to produce a comprehensive finding.

The questionnaire consists of six sections, starting with a clear message to the teachers about the purpose of asking them to fill the survey and promising them to maintain the confidentiality of their feedback and data and that they will never be shared with their schools. Teacher questionnaires are structured to contain both closed and open-ended questions to gather more information and opinions from participants to enable the researcher to dive in-depth to understand the teacher's perspective toward the Alef Platform. Close-ended questions used a 5-Likert scale where five is considered very high, and one is very low. The first part has six questions aimed to gather basic socio-demographic information about participants' role in the school, their age, their subject, their region and gender through direct close-ended questions. In the second part, the teachers are asked to rate their skills in using technology, the challenges that they faced using technology and the professional development training that they received toward implementing the

Alef Platform. The third part consists of 7 questions, starting with asking the teachers to what extent they agree that the Alef Platform improves teaching and learning, student outcomes, student engagement and motivation, students' behaviour and that it helps students to explore new contents and build new skills. The fourth part of the questionnaire asked the teachers to rate the level of consistency in using the Alef Platform, particularly in checking their students' data in and out of the classroom. The fifth part has five questions aimed at understanding the extent to which the automated tools and ready resources available on the Alef Platform saved their time and effort. The sixth and last part of the closed-ended questions was about the role of the Alef Platform in changing the teachers' role from the traditional role of instructing to that of a facilitator or coach. Finally, the questionnaire ends with three open-ended questions in order to obtain more information from participants about the challenges that they faced while using the Alef Platform, how the platform supports them during COVID-19 and their general opinion about the Alef Platform.

3.3.2.3 Pilot teachers' survey

For the purpose of checking the validity and reliability of the questionnaire and to ensure its practicality, the researcher conducted a pilot study with a small sample of participants who apply the full-scale questionnaire, which is considered a pre-test of the study instruments (Golafshani 2003). The data and results of this pilot are analyzed using the IBM Statistical Package for the Social Sciences (SPSS, version 20.0). The aim of conducting this pilot is to improve and increase the confidentiality of the research instruments, which ultimately results in producing valid findings. This pilot questionnaire was conducted in June 2020 on a sample of participants who have characteristics similar to those of the real participants. According to Fincham (2008), the pilot sample size should be 10-20% of the actual size of the schools that implement the Alef Platform. The teachers received an invitation to participate in the pilot via their emails or via text messages on their phones that included a link to the survey. The pilot survey was sent to 2 schools (one girls' school and the other is boys' school) that have 80 teachers and administrative staff members. The researcher received 54 participation, an equivalent to 67.5% of the targeted applications. According to Fincham (2008), the acceptance survey participation rate for any research should be approximately 60%. This means that the participation rate in the pilot questionnaire is accepted. The participants consisted of 26 females (48%) and 28 males (51.8%), age groups distributed as nine less than 30 years, 25 between 31 to 40 years, 14 between 41 to 50 years and six between 51 to 60 years, as shown in chart 3.1. The respondents' experience in education is distributed as follows: 6 of them have less than six years of experience, 16 teachers have experience from 5 to 10 years, ten teachers have experience from 10 to 15 years, nine teachers have years of experience between 15 to 20 years, eight teachers have years of experience between 20 to 25 years and five teachers have more than 25 years of experience in education as shown in Chart 3.2. The participants covered all subjects as shown in Chart 3.3, and more than 90% of the respondents rated their skills using technology even high or very high, and 9% rated their skills as a medium.

Chart 3 1 Pilot age group

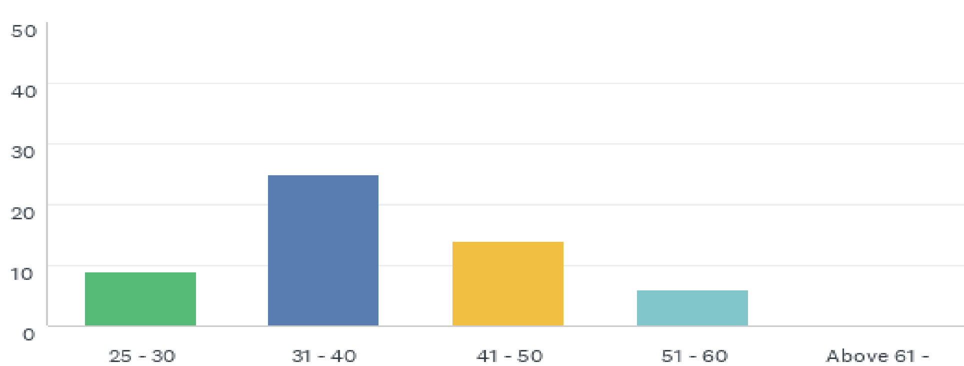


Chart 3 2 Pilot responses' years of experience

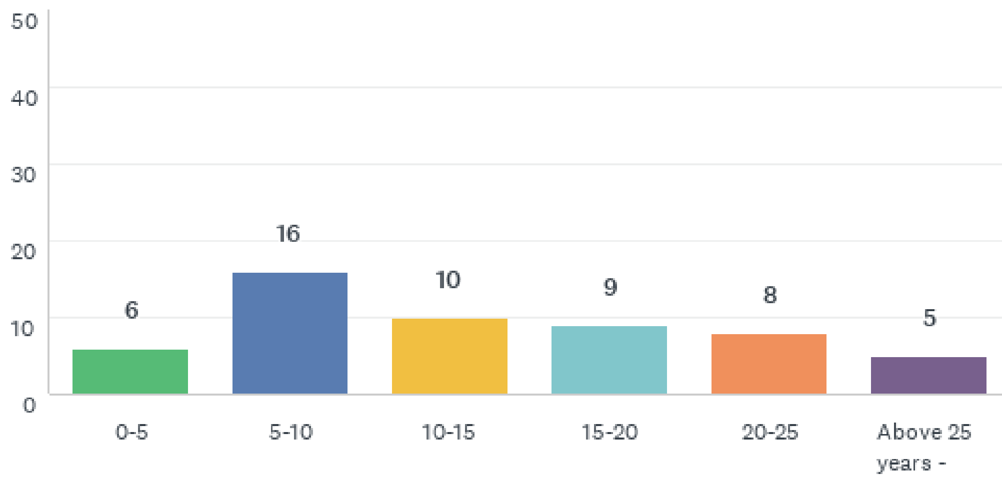
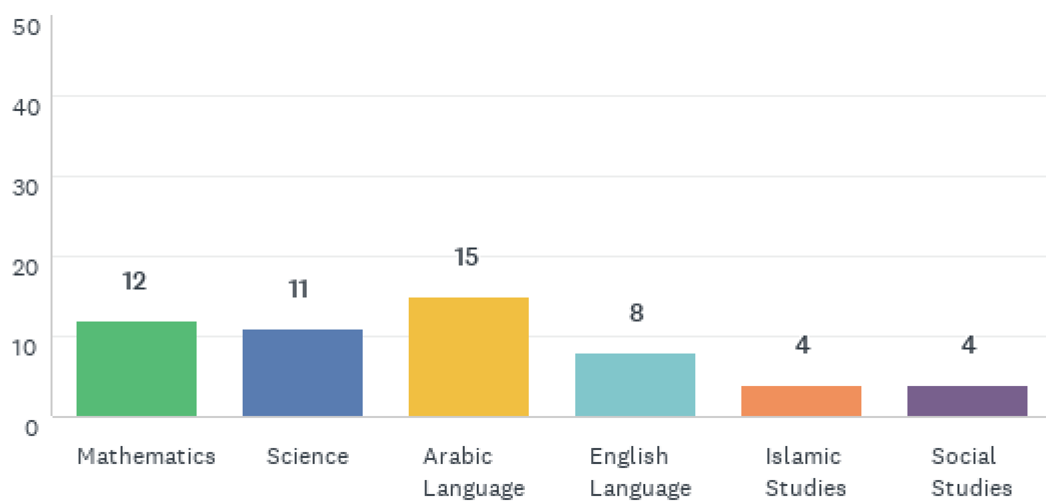


Chart 3 3 Pilot Survey - Teachers' subject



Reliability and Validity in the teacher survey pilot

The reliability testing of the survey questionnaire was carried out by using Cronbach's alpha for all closed-ended questions in the questionnaire. The data that was obtained from the pilot survey was analyzed using SPSS. Each item in the pilot questionnaire has a Cronbach's alpha coefficient of above 0.7, which is a mandate for the questionnaire items to be deemed reliable. According to Brymab & Cramer (2011), for any item in the questionnaire to be considered reliable, the Cronbach Alpha value should exceed 0.7. As shown in Table 3.2 below, which was generated from the SPSS program, the validity of all variables is 100%. In addition, the Cronbach's alpha shown in the Reliability Statistics Table 3.3, which was generated using the SPSS program, is 0.929, which is way above 0.7.

Table 3 2 Case Processing Summary

		N	%
Cases	Valid	44	100.7
	Excluded[a]	0	0
	Total	44	100.0

Table 3 3 Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.929	.934	21

The significance test in the T-Squared test, as shown in Table 3.4 below, is 0.000 and the significance test in the Intraclass Correlation Coefficient as shown in Table 3.5 is 0.000, which indicates that this study provides strong and significant results.

Table 3 4 Hotelling's T-Squared Test

Hotelling's T-Squared	F	df1	df2	Sig
178.277	4.975	20	24	.000

Table 3 5 Intraclass Correlation Coefficient

	Intraclass Correlation[b]	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.384[a]	.288	.509	14.095	43	860	.000
Average Measures	.929[c]	.895	.956	14.095	43	860	.000

Two-way mixed-effects model where people effects are random and measures effects are fixed.

a. The estimator is the same, whether the interaction effect is present or not.

b. Type C intraclass correlation coefficients using a consistency definition. The between-measure variance is excluded from the denominator variance.

3.4 Data analysis procedure

In this thesis, two different software are used to analyze the data: Jupyter Software and Statistical Product and Service Solutions Program (SPSS). The Jupyter software is used to analyze the data collected via the Alef Platform, Ministry of Education final exams and the diagnostic tests. To analyze these three groups of data, the researcher uses the Python programming language on the Jupyter software, specifically on the Jupyter Notebook. As explained above, the researcher received the raw student data in the form of Excel Spreadsheets, then imported them to the Jupyter Notebook Software to proceed with the analysis steps.

According to Randles et al. (2018), the Jupyter Notebook is a free and open-source tool that can be accessed using web browsers to perform data analysis, establish codes, create a sequence of the research activities, and generate visual aids to visualize the data results after analysis. Jupyter notebooks also help the researcher create a code or function in Python language that shows the correlation between different elements related to the research objectives by answering the research questions.

The Jupyter Notebook has two main advantages that encourage the researchers to use this software over other options; first, the seamlessness of the process to reach the required results and connections between the research elements; secondly, the ability to handle huge amounts of data. According to Perkel (2018), data processing can be performed in two main stages using Jupyter Notebook. The researcher initiates the process by entering the data and the programming code or function in a front-end webpage. After that, the code is passed by the browser to a back-end kernel to run the code and provide the results of the data analysis process. The programming language used on Jupyter Notebook is Python (Perkel 2018). According to Murray, Jupyter Notebook is a flexible software that analyzes massive amounts of data and helps in academic research. The software has become popular in solving education research problems to improve education, especially in “Big Data” environments (Murray 2013).

This software is used to understand the impact of digital learning on 7,039 students from 12 schools in two different groups. The first group of students study in schools that started to implement the Alef Platform in 2018, while the other group attended schools that started to implement the Alef

Platform in 2019. Using this software enabled the researcher to analyze a huge amount of data related to the performance of the 7,039 students. The researcher used the software to analyze the results of the MOE centric exams acquired by those 7,039 students and compare the students results in the 2018 schools' group and 2019 schools' group in the final MOE exams of Term One of the academic year 2019/2020. MOE master exam results, and Alef summative assignment data, time spent in the lesson, completed lesson using the Alef Platform during 2019/2020 and also diagnostic test results for those students.

There are two tests conducted in this study to analyze the data, namely, Pearson and Spearman Rank correlation coefficients and the Mann-Whitney U test. Pearson and Spearman's tests are run to measure the relationship studies needed, and the Mann-Whitney U test is used when the researcher compares the two groups of schools. The next section presents a background of each of the mentioned tests.

In 1896, the first Pearson product-moment correlation coefficient (rp) was created and eight years afterwards, in 1904, the Spearman rank correlation coefficient (rs) was developed to be used by psychological researchers (de Winter, Gosling & Potter 2016 p.273).

According to de Winter, Gosling & Potter (2016), "The Pearson product-moment correlation coefficient (rp) and the Spearman rank correlation coefficient (rs) are widely used in psychology, with rp being the most popular. The two coefficients have different goals: rp is a measure of the degree of linearity between two vectors of data, whereas rs measures their degree of monotonicity" (P. 284).

According to Schober, Boer and Schwarte (2018), correlations are essentially used to measure the relationship between variables; any change is any of the variables means a change takes place in another associated variable. This change could indicate a positive correlation, which means that the variables witness a change in the same way, or a negative correlation, meaning that the variables are associated through an opposite relationship. In the Pearson product-moment correlation coefficient, the concept of correlation is used to show a linear relationship between 2 variables, given that the data is distributed normally. Spearman rank correlation coefficient measures ordinal, non-normally distributed data and data that has relevant outliers. The scale of Pearson's and Spearman's correlation coefficients ranges between –1 to +1, where 0 means that there is no correlation between the variables, and the closer we get to the absolute value of -1 or +1, the stronger the relationship, whether positive or negative, is between the variables (Schober, Boer & Schwarte 2018).

The letter "r" is used to denote the relationship between the variables and is followed by a number that measures this relationship. The number should range between -1 and +1; 0 indicates that there is no relationship between the variables, and 1 means a perfect correlation. Moving in the direction from 0 to +1 means that the relationship is positively increasing in strength while moving towards -1 denotes that the relationship is negatively increasing in strength. In order to raise the validity and reliability of the results, the p-value must be closer to 0 where the p-value presents the probability that this correlation coefficient may happen by chance (Akoglu 2018).

Pearson correlation coefficient approaches in a straight line, while Spearman correlation coefficient takes shape in a curve that shows either a consistent decrease or increase as the coefficient approaches the absolute value of 1 (Schober, Boer & Schwarte 2018).

To find out if there is a difference in diagnostic tests between students who started with Alef in 2018 and students who started in 2019, the researcher used hypothesis testing, and the Mann-

Whitney test is used for this hypothesis test. The Mann-Whitney U test is a non-parametric test that can be used in place of an unpaired t-test. It is used to test the null hypothesis that compares two independent groups or samples from the same population, meaning that the samples have the same median or the opposite alternative hypothesis - whether the observations in one sample tend to be larger than the observations in the other. Although it is a non-parametric test, it does assume that the two distributions are similar in shape (Nachar 2008). This test was originally created by Wilcoxon in 1945 to analyze the relationship between two samples, provided that both samples are of the same size. Then in 1947, Mann and Whitney improved that test to be able to analyze the relationship between samples that have different sizes; and they named it the Mann-Whitney U test (Das 2018).

The Mann-Whitney U test compares pairs of observations from two groups. For example, if the observations of the first group are: x1, x2, x3, …, xn; and the observations of the second group are y1, y2, y3, … yn; then the comparison should be made between x1 and y1, x2 and y2, and so on. If the median is the same for both samples, this means that these two samples have an equal probability of being greater and smaller than each other. With the Mann-Whitney U Test, two hypotheses should be studied, one of them being the opposite alternative to the other. If the first hypothesis suggests that the first group is greater than the second group, then the second hypothesis should suggest that the second group is greater than the first group (Bürkner, Doebler & Holling 2016).

The Mann-Whitney U test is a non-parametric test that can be used in place of an unpaired t-test. It is used to test the null hypothesis that two samples come from the same population, and they have the same median or whether observations in one sample tend to be larger than observations in the other. Although it is a non-parametric test, it does assume that the two distributions are similar in shape.

The common language effect size (CLES) indicator shows the differences and variances between the samples of the independent groups by calculating and comparing the sample means and pairs of observations (Krasikova & Le 2017).

The teachers' survey analysis is done by using SPSS. According to Hox et al. (2017), using specialized statistical software is powerful when it is used to analyze huge amounts of data, especially software that has the options for analysis. For this study, the researcher chooses to analyze data using SPSS and SurveyMonkey analytical tools.

According to Fraenkel, Wallen, & Hyun, 2012, in order to analyze qualitative data and results, coding can be used. The researcher employs coding to analyze the qualitative data collected from the teachers' survey. The researcher defines specific words to include in the code so that once the code runs, it captures the answers and classifies them into groups based on these words. This helps the researcher categorize the answers into groups that share similar standing points, allowing for easier analysis of open-ended questions.

According to Campbell, Quincy, Osserman, & Pedersen (2013), the reliability of qualitative data depends on three factors: stability where the coder does not change the code over time, accuracy where the coding scheme created is highly reliable, and reproducibility where different researchers use the same coding scheme for the same data. In this research, the researcher makes sure to have all these factors while coding the scheme to be used to analyze the qualitative data.

For the purposes of analyzing the qualitative data collected in this study, the researcher bases the analysis on the data emerging from the participants in their response to the Teachers' Survey. The researcher used coding to divide the received data into themes that emerge from the participants' answers, as the researcher doesn't have prior themes. Based on the word cloud tool in SurveyMonkey, the words and phrases that are repeatedly used are captured as themes. The tool also includes the number of times each word and phrase is used and list them in order of repetition in usage. The participation and answers of the teachers are classified into groups that answer the research questions. The first group includes the answers that mention student learning improvement; the second group includes the answers that are related to the teachers' role and how the platform supports them; the third group includes the answers that talk about the challenges that teachers face using the platform, and the fourth group includes the teachers' feedback on online learning during COVID-19.

3.5 Ethical considerations

This research adheres to all the ethical protocols and principles of research, such as privacy, confidentiality, and anonymity (Roberts, & Allen 2015). The research proposal was reviewed and evaluated by the Research Ethical Panel at the British University in Dubai. The guidelines applied are in accordance with the Standards for Protection of Human Subjects and the respective policies and guidelines. The Research Ethical panel considers this research as minimal risk. The researcher obtained an approval letter from the University for the purpose of collecting data and starting the procedure, Appendix (2). After that, the researcher was granted the approval letter (Appendix 3) from the Abu Dhabi Department of Education and Knowledge (ADEK) to start the study, collect student data and conduct the teachers' survey.

In this thesis, the researcher collected and used three different pools of primary data organized as the student ID, school ID and the score for each subject as mentioned under the instrument sections, namely, Ministry of Education's centric exam results, Alef login and used data and the diagnostic test results. All the data collected to be used for this study does not require students' names or any personal information. Students' data was kept confidential, and numbers, not names, were used to identify students as a way to ensure everyone's privacy is respected.

The teachers' survey started with a message that explained the purpose of conducting the survey and mentioned that all responses and opinions will not be shared with anyone and that they will be kept confidential and secure. The survey was sent to the teachers automatically through the SurveyMonkey platform to be filled voluntarily and out of the participants' own accord. The survey didn't request the participant to provide any names or personal information, whether related to the teacher or the school.

3.6 Conclusion

This chapter presents the thesis methodology and approach and gives a brief overview of the research design, including the sample size of participants. It also explains all the instruments used to collect the quantitative and qualitative data and the testing tools used to analyze the collected data. The chapter concludes with the ethical considerations that the researcher took in collecting and analyzing the data.

CHAPTER 4:

QUANTITATIVE AND QUALITATIVE DATA ANALYSIS

4.0 Introduction

The purpose of this chapter is to present the analytical, quantitative and qualitative data underpinning the research questions. The first section of this chapter presents the quantitative data the researcher collected and its analysis, while the second section focuses on the qualitative data and analyses it. The researcher used different instruments to collect the data that was used in this thesis. There are four main questions that this thesis tries to answer to help investigate the impact of AI-Powered digital educational platforms drive and improve student learning and teacher practice in Abu Dhabi schools. The purpose of each of these four questions is centred around understanding the impact of the AI-powered Platform on improving students' learning and their engagement with this AI-driven platform, understanding the perspective of the teachers towards using an AI-powered digital platform and its impact on their practice and how AI-driven digital learning supports students and teachers during the COVID-19 pandemic. Below are the main four questions of this thesis:

1. How does AI-driven digital learning improve students' learning?
2. What are the teachers' perceptions of AI-powered digital learning platforms?
3. How does the implementation of AI in digital learning impact teachers' practice?
4. How do AI-powered digital learning platforms help students and teachers during Coronavirus (COVID-19) pandemic?

Four instruments were used in this thesis to collect the data; these instruments are: a teachers' survey that includes closed-ended and open-ended questions, centric exam results conducted by the UAE's Ministry of Education, diagnostic tests done by a third party, and data that shows students activities on the Alef Platform including, formative and summative assessment scores, the time spent on the Alef Platform, the number of completed lessons and other test scores done on the Alef Platform. The chapter is divided into two main sections: quantitative data analysis and qualitative data analysis. The first section starts with explaining the analysis process and shows the students' and teachers' demography, and later moves to explain the data analysis and present the relationships in relation to each thesis question. The second section explains the qualitative data analysis process and protocol followed and the tools used; then, it moves to answer the thesis questions from the teachers' perception.

4.1 Quantitative Data Analysis

This section presents the entire analysis of the quantitative data collected from 12 schools that covers 7,039 students and 512 teachers. Six of the schools started using the Alef Platform in 2018, and 6 schools started implementing the platform a year later, in 2019. The data collected in total from the 12 schools over the academic year 2019/2020; the same type of data was collected from all students practising over the same period of time and the same type of activity and assessment. This quantitative data is collected from the MOE Centric Exam results, the diagnostic test results, the Alef Platform usage data, as well as the Teachers' Survey. The below sections include an explanation of the analysis process applied for each type of the collected data.

4.1.1 Quantitative Data from Centric Exams, Diagnostic Tests and Alef Platform

This section explains the analysis process of student data collected from the Alef Platform usage data, MOE final exam results and diagnostic test results. This data was collected in the form of primary and raw data and then analysed in the Python programming language using the Jupyter software, specifically Jupyter Notebook. The below table shows the distribution of the 7,039 students according to their school IDs.

The IDs of the schools included in this study are listed under the column school_dw_id with the number of students from each of these schools mentioned in the corresponding column under the title number_of_students. The schools that started implementing the Alef Platform in 2018 “Group 2018” are 96, 120, 124, 92, 128, 332. The schools that began using the platform in 2019 “Group 2019” are 38, 292, 180, 168, 316, 6.

Table 4. 1 Distribution of students

school_dw_id	number_of_students
6	535
38	639
92	925
96	597
120	479
124	626
128	693
168	548
180	308
292	586
316	628
332	475

This chapter presents the analytical data according to the five main aspects of this thesis: the demography of the students, the impact of AI-driven Platforms on students’ performance, the impact of AI-driven Platform on students’ engagement, the impact of AI-driven Platform on teachers’ practice and the role of AI-powered platform in COVID-19 situation. Each of the aspects is discussed separately below.

4.1.2 Teacher Survey Quantitative Data

The researcher conducted a teacher survey to provide an in-depth investigation into the teachers' perspective on the implementation of the Alef Platform - an AI-powered digital learning platform. The survey was analyzed using the IBM Statistical Package for the Social Sciences (SPSS). This survey was sent to almost 600 teachers and administrative staff members in all 12 targeted schools, 6 girls' schools and 6 boys' schools. The teachers received an invitation to participate in the survey via email or text message with a link to the survey. The researcher received 512 responses, which constitutes a participation rate above 85% of the total number of applications sent. The majority of responses were from teachers, 98%, and the least from the administration staff, 3 of whom were from school principals.

The reliability testing of the survey questionnaire was carried out using Cronbach's alpha for all closed-ended questions included in the questionnaire. Table 4.2, which was generated using the SPSS program, shows that the Cronbach's alpha is 0.949, which is much higher than 0.7; and Table 4.3 shows that the validity is more than 95%.

Table 4. 2 Reliability statistics

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.949	.952	24

Table 4. 3 Case processing summary

Case Processing Summary

		N	%
Cases	Valid	490	95.7
	Excluded[a]	22	4.3
	Total	512	100.0

a. Listwise deletion based on all variables in the procedure.

As previously mentioned in the Methodology Chapter, this survey has six sections; five of which include closed-ended questions, while the last section consists of open-ended questions. Close-ended questions used a 5-Likert scale where five is considered very high and one very low. The first section aimed to gather basic socio-demographic information about participants' role in the school, their age, their subject, their region and gender through direct close-ended questions. In the second part, the teachers are asked to rate their professional development and skills in using technology. The third section consists of 7 questions about the teachers' perspective on the impact of implementing the Alef Platform on students' performance and engagement. The fourth and fifth sections inquire about the impact of the implementation of the Alef Platform on teachers' practice, ending with a question about the role of the Platform during the COVID-19 Pandemic. The last section of the survey includes three open-ended questions that the researcher explains in Chapter six.

Table 4.4, which was generated using the SPSS program, shows the T-Squared test, where the significance rate is .000, which indicates that the result of this survey is very significant.

Table 4. 4 Hotelling's T-Squared Test

Hotelling's T-Squared Test

Hotelling's T-Squared	F	df1	df2	Sig
1429.515	59.357	23	467	.000

The next section analyses the demography of the teachers who participated in the Teachers' Survey as well as the teachers' ability to employ technology in the classroom and the professional development. The analysis of the remaining survey results is integrated into the related sections with the other quantitative results according to the four main aspects of the thesis. The final open-ended question included in the survey is separately analyzed at the end of this chapter.

4.1.3 Demographic Analysis of Participating Students and Teachers

The data collected and analyzed covered 7,039 students and 512 teachers. This number is statistically relevant and provides valid and appropriate conclusions to the thesis. The 7,039 students are distributed over 12 schools: 6 are girls' schools, and 6 are boys' schools. The age and grade group is between 11 to 15 years old, grades 5 to 9. The demographics of the participating students are more thoroughly explained in this section.

4.1.3.1 Students Demography

Chart 4.1 below shows the number of students per region, with 3,342 students studying in schools distributed across Abu Dhabi and 3,697 students in schools located in Al Ain.

Chart 4. 1 Number of Students per Region

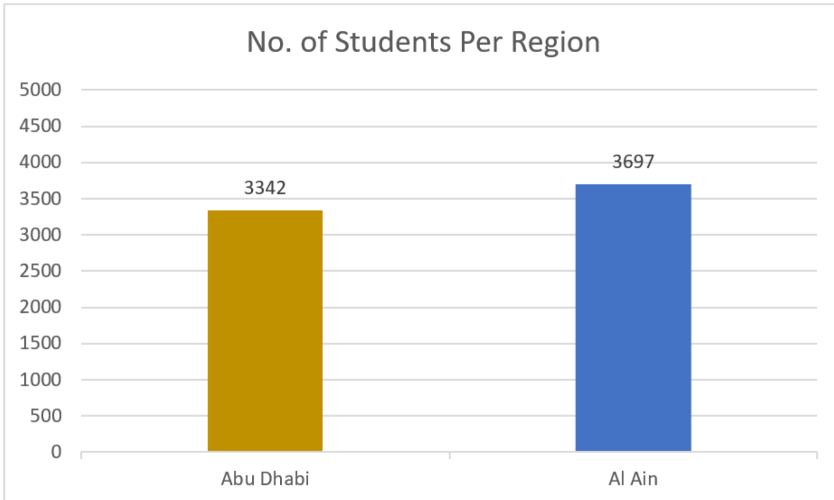


Chart 4.2 below shows the number of students per gender, where 3,618 shows the number of female students and 3,421 indicates male students.

Chart 4. 2 Number of Students per Gender

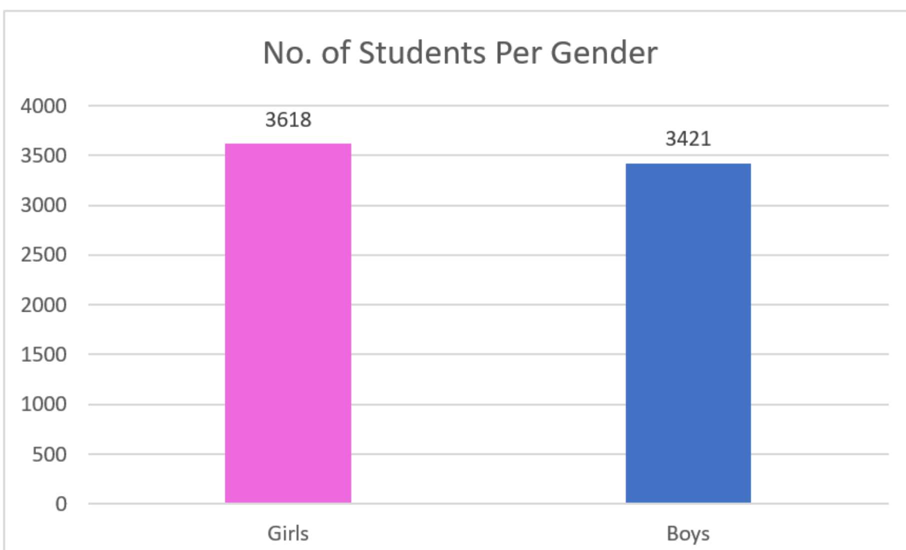
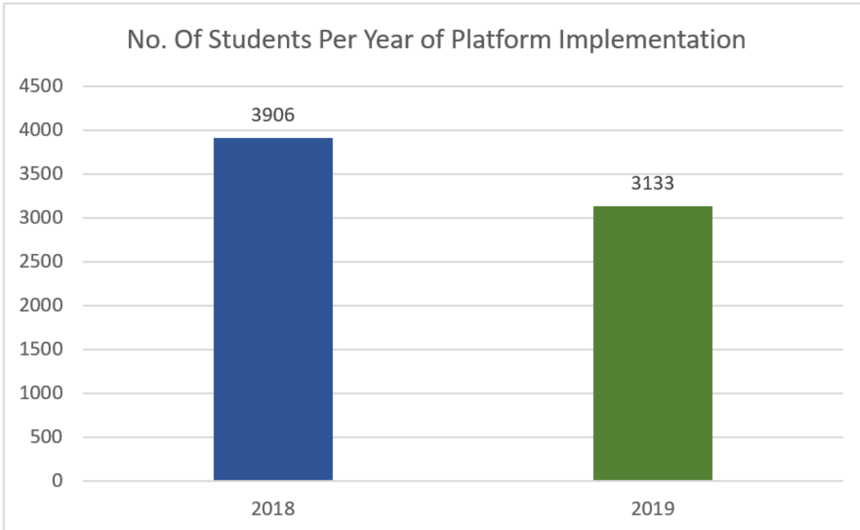


Chart 4.3 below shows the number of students per the year of implementation of the Alef Platform, where 3,906 students started to implement the Alef Platform in 2018, and 3,133 students started to implement the platform a year later in 2019.

Chart 4. 3 Number of Students per Year of Platform Implementation

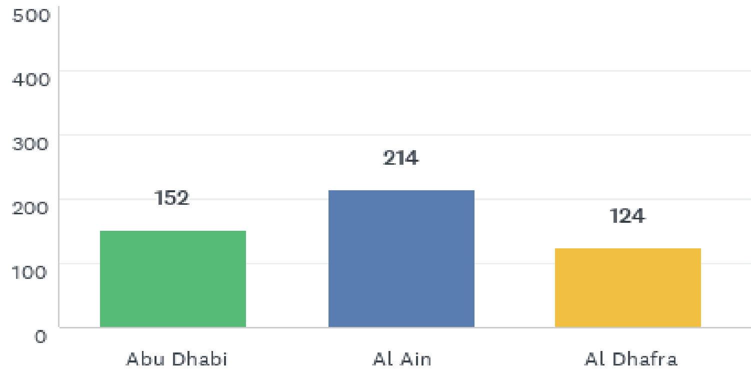


4.1.3.2 Teachers Demography

As for the teachers, the demographic is 321 female teachers and 191 male teachers, aged between 25 to 60 years old, with experience in the field that ranges between 1 year up to 30 years, and 152 of whom come from Abu Dhabi, 212 from Al Ain, and 124 from Al Dhafra. The subjects that the participants teach are 119 mathematics teachers, 131 science teachers, 107 Arabic language teachers, 69 English language, 49 Islamic studies teachers and 37 social studies teachers. The demographics of the participating teachers are more thoroughly explained in this section.

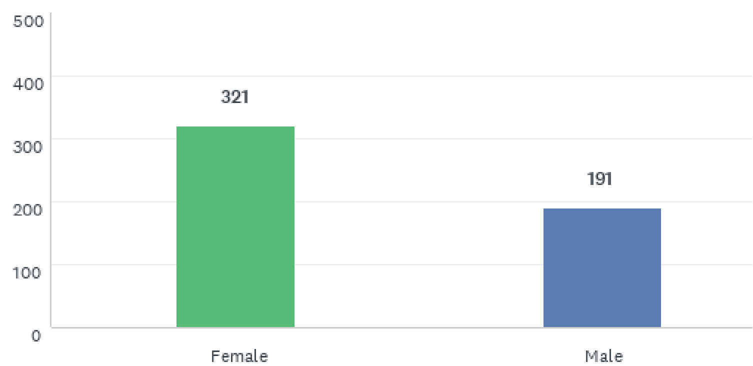
The collected responses were from teachers working in different areas in the emirate of Abu Dhabi - 152 participants were from Abu Dhabi, 214 from Al Ain and 147 from Al Dhafra (Western Region), as shown in Chart 4.4 below.

Chart 4. 4 Number of Teachers per Region



The participants consisted of 321 females (63%) and 191 males (37.8%), as shown below in Chart 4.5.

Chart 4. 5 Number of Teachers per Gender



The participants consisted of age groups distributed as 63 less than 30, 194 between 31 to 40, 187 between 41 to 50 and 68 between 51 to 60 as shown in Chart 4.6 below.

Chart 4. 6 Number of Teachers per Age Group

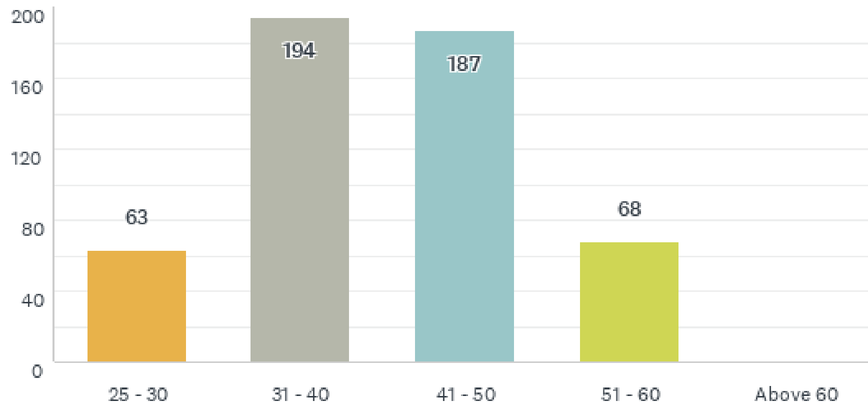
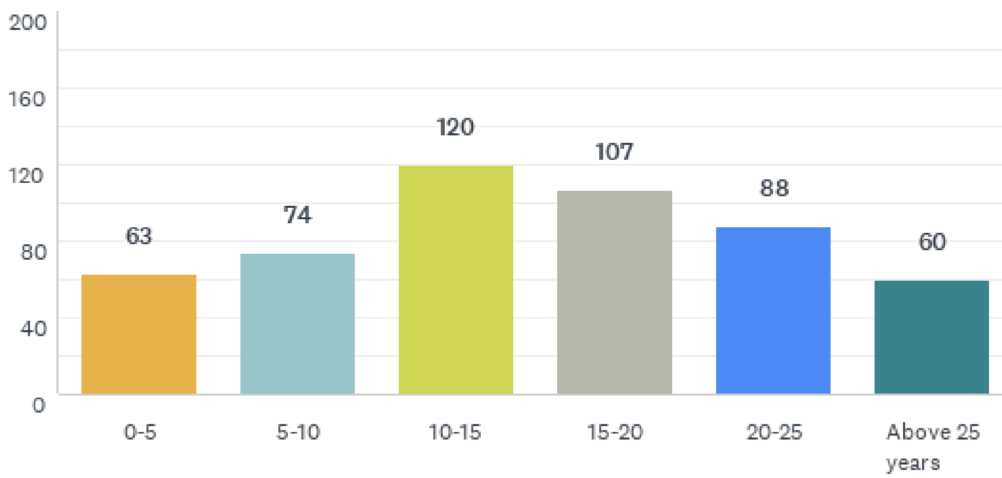
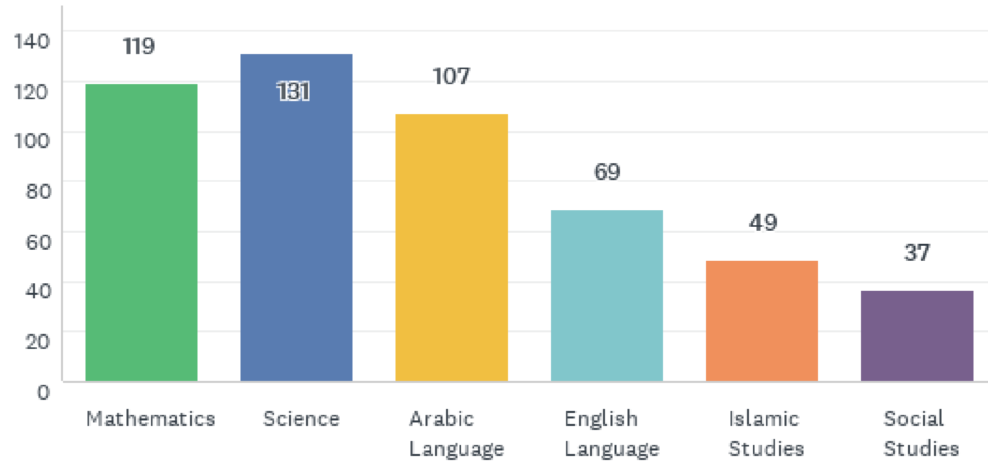


Chart 4. 7 Number of Teachers per Years of Experience



The respondents' experience in education spans as follows: 63 of them have less than 6 years of experience, 74 teachers have an experience that ranges from 5 to 10 years, 120 teachers have experience ranging from 10 to 15 years, 107 teachers have between 15 to 20 years of experience, 88 teachers have between 20 to 25 years of experience and 60 teachers have more than 25 years of experience in education, as shown in Chart 4.7 above.

Chart 4. 8 Number of Teachers per Subject



The responses received were from teachers that cover all core subjects; 119 Mathematics teachers, 131 Science teachers, 107 Arabic language teachers, 69 English language teachers, 49 Islamic Studies teachers, and 37 Social Studies teachers, as shown in Chart 4.8.

4.1.4 Students' Data Analysis

The following section presents the analysis of the data provided on the students; including, the student results in the MoE centric exams, the student results in the diagnostic tests as well as the data collected from the Alef Platform on the student activity on the platform. Additionally, the section will cover the data collected on the teachers' perceptions with regards to the impact of the platform on student learning collected from the teachers' survey, which was conducted in parallel to give a deeper understanding of the results of the data analysis collected using the three previously mentioned instruments.

4.1.4.1 The impact of AI-driven Platforms on students' performance

This section presents data analysis that can suggest an answer to the first thesis question - How does AI-driven digital learning improve students' performance?

The data used to answer this question are the students' results in the final exams conducted by the UAE's Ministry of Education, the diagnostic test results and data collected from the Alef Platform on the learning experience of the students. This data includes the average formative and summative assessment scores, the number of completed lessons on the Alef Platform and the average time spent per stage for each student in the 12 schools over the academic year 2019-2020.

Table 4.5 below explains the different stages during a student's learning experience on the Alef Platform. The metric we used is the average time a student spends per stage over the academic years 2019-2020.

Table 4. 5 Definitions of Stage/Breadcrumb Symbols

Stage/Breadcrumb	Symbol	Definitions
The Big Idea	AC	Video to gain students' attention, introduce the lesson, and inform students of the learning objective
Depth of Knowledge 1	LESSON_1	Content that requires students to recall, define, list and identify information
Check my Understanding 1	TEQ_1	Formative assessment (students who do not achieve 100% move to the Second Look)
Second Look	R	Presents the content through a simplified approach
Depth of Knowledge 2	LESSON_2	Content that requires students to graph, classify, compare and summarize information

Check my Understanding 2	TEQ_2	Formative assessment
Depth of knowledge 3	LESSON_3	Content that requires students to assess, investigate, construct and draw conclusions
Check my Understanding 3	TEQ_3	Formative assessment
Last Look	SUM	Video to enhance the student's retention and transfer of knowledge
My Exit Ticket	SA	Assessment

Table 4.6 below shows an example of some of the rows that show how the data on the Alef Platform looks like.

Table 4. 6 Data on the Alef Platform

student_school_id	school_dw_id	number_completed_lessons	total_sa_score	avg_SA	total_breadcrumbs	total_gettimesessioncalculated	avg_breadcrumb_time
120027083eb-9d82-478e-8f20-47516cea583a	120	126.0	10005.0	79.404762	1529.0	204643	133.841073
12003a2784b-ab83-482e-9c86-1574ab8d3a10	120	187.0	14600.0	78.074866	1697.0	275002	162.051856
120041cd8ad-ca9f-4ec5-9501-b50b53f5d814	120	236.0	21880.0	92.711864	2103.0	353164	167.933428
120045a0d4d-57d1-4149-b35c-46d3051e2938	120	115.0	9521.0	82.791304	1336.0	232566	174.076347
1200490b135-47bf-4e98-8fd4-7d5ccfead27f	120	130.0	10261.0	78.930769	1815.0	288727	159.078237

*Note: avg_*breadcrumb_time i*s the average time taken per stage*

As shown in the above extract taken from the Alef Platform's data, each student has a unique student_school_id with an average summative assessment score and an average time spent per stage associated with it.

4.1.4.1.1 The relationship between the time spent on Alef Platform and summative assessment (SA) score

To find out if there is a relationship between the time spent on the Alef Platform and the mastery of the final concept, the researcher calculated the Pearson correlation coefficient and the Spearman correlation coefficient. The coefficient shows more the statistical relationship between the average of the summative assessment score and the average time spent per stage per student. The researcher used the stats module in Python that provides functions to calculate the coefficients: Pearson r and Spearman r for Pearson and Spearman correlation coefficients, respectively.

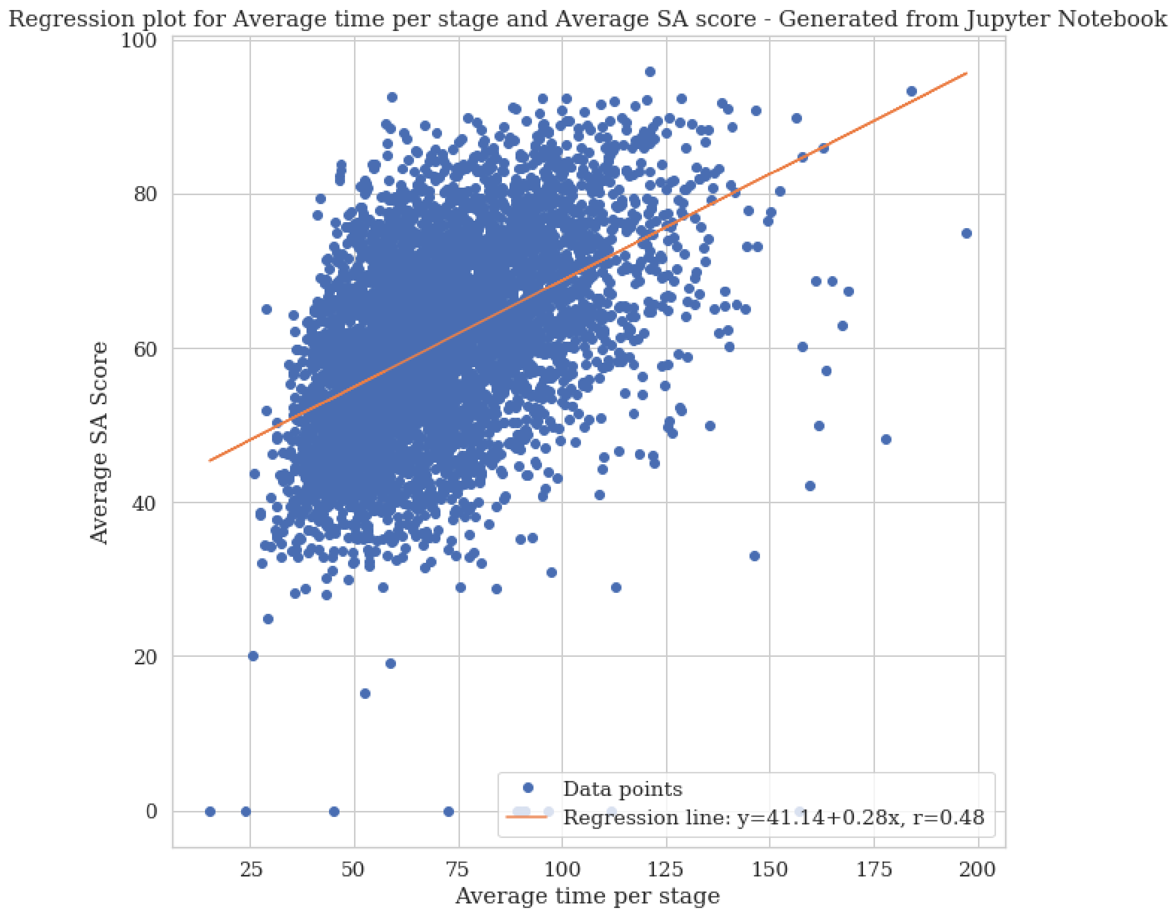
The data frame of Alef data is called the per_student_df in the Jupyter notebook. The research then ran the mentioned functions, which produced the following outputs:

The output of applying the Pearson correlation coefficient:

```
stats.pearsonr(per_student_df['avg_SA'], per_student_df['avg_breadcrumb_time'])
(0.5204923555127002, 0.0)
```

The above output shows that 0.52 is the resulting Pearson correlation coefficient. The Pearson relationship coefficients can run in an incentive from -1 to +1 (Chandhini & Vaishnavi M 2017). The strength of the correlation grows both from 0 to +1 and 0 to -1 (Akoglu 2018). The p-value is 0, which means that the probability that this strength may occur by chance is 0. The graph below shows the data point and regression line; the X-axis denotes the average of time spent on each stage (Breadcrumb time), and the Y-axis is the average of the summative assessment (SA) score. This plot is created using the linregress function in the stats module. It visually represents the correlation between the average summative assessment scores and the average time spent per stage on the Alef Platform.

Figure 4. 1 Regression plot for average time per stage and average SA score



The output of applying the Spearman correlation coefficient:

```
stats.spearmanr(per_student_df['avg_SA'], per_student_df['avg_breadcrumb_time'])
SpearmanrResult(correlation=0.4825730567463826, pvalue=0.0)
```

The above output shows that 0.48 is the Spearman correlation coefficient, and the p-value is 0.

From the calculation of the two correlation coefficients and the p-value, it can be indicated that the two coefficients are similar, approximating 0.5, while the p-values are 0. The correlation coefficient is positive, which represents a positive relationship between the average of the summative assessment scores and the average time spent per student. A correlation coefficient of 0.5 means that the average summative assessment score and the average time per stage (breadcrumb) is moderately correlated.

"The p-value is the probability that you would have found the current result if the correlation coefficient were, in fact, zero (null hypothesis). If this probability is lower than the conventional 5% (P<0.05), the correlation coefficient is called statistically significant." (www.medcalc.org 2020, P2).

The results have a p-value of 0 and based on the above explanation, knowing that the p-value is lower than 0.05 means that the correlation coefficients are statistically significant. Hence, the result is significant, i.e. there exists a positive and moderately strong relationship between the average summative assessment score and the average time per stage (breadcrumb) on the Alef Platform.

In general, the data paints a positive picture; however, there are anomalies showing that few students spend a long time on the platform but get low scores in the assessment activities. Such students could be struggling due to language barriers or other learning difficulties.

4.1.4.1.2 The relationship between summative assessment score and the Ministry's exam

This section is aimed at understanding the extent to which there is a correlation between the average summative assessment scores obtained on the Alef Platform and the average results in the final ministry exams.

To find an answer to this question, the researcher used the Alef Platform data and the ministry exams data for the 2019-2020 school year. Table 4.7 below is an extract taken from the Alef

Platform data for each student, presenting the average of the work for the whole academic year of 2019-2020. The avg_SA column lists the average summative assessment score for each student to be compared with the data showing the results of the final ministry exams to find out if there is a relationship between them or not.

Table 4. 7 Summative assessment data in the Alef platform

student_school_id	school_dw_id	number_completed_lessons	total_sa_score	avg_SA	total_breadcrumbs	total_gettimesessioncalculated	avg_breadcrumb_time
120027083eb-9d82-478e-8f20-47516cea583a	120	126.0	10005.0	79.404762	1529.0	204643	133.841073
12003a2784b-ab83-482e-9c86-1574ab8d3a10	120	187.0	14600.0	78.074866	1697.0	275002	162.051856
120041cd8ad-ca9f-4ec5-9501-b50b53f5d814	120	236.0	21880.0	92.711864	2103.0	353164	167.933428
120045a0d4d-57d1-4149-b35c-46d3051e2938	120	115.0	9521.0	82.791304	1336.0	232566	174.076347
1200490b135-47bf-4e98-8fd4-7d5ccfead27f	120	130.0	10261.0	78.930769	1815.0	288727	159.078237

Table 4.8 below shows the final ministry exam data and presents how the first five rows of the final ministry exams' data look like for the 2019-2020 school year. The average final score is calculated for each student. The average_final column shows the average of all the scores over Term 1 and Term 3 over the different subjects for the ministry exams for each student.

Table 4. 8 Students' average final score in the Ministry final exam

student_school_id	average_final
12400277183-f035-4a74-a03b-99bfdc244ae6	78.395455
124011d7e1c-b6fa-487b-a688-cee794b273da	50.820000
124018326e8-2101-463f-89e3-1118b0119694	82.915833
12402504826-ddb9-45b2-8b11-a85e8a2ea2ff	78.720909
12402c1bb76-69b3-4848-8a4f-2bace7db50e5	72.500000

The student_school_id from the ministry exam are matched to the Alef Platform data so that the researcher can see an average summative assessment score and an average Ministry final score for each student and then calculate the correlation between the SA scores on the Alef Platform and the results of the final Ministry of Education's scores. After matching student_school_id's, a new data frame is generated. Table 4.9 below presents the newly extracted data.

Table 4. 9 Combining students score in the final exam and average summative assessment

student_school_id	average_final	avg_SA
12400277183-f035-4a74-a03b-99bfdc244ae6	78.395455	58.025641
124011d7e1c-b6fa-487b-a688-cee794b273da	50.820000	37.532710
124018326e8-2101-463f-89e3-1118b0119694	82.915833	75.951407
12402504826-ddb9-45b2-8b11-a85e8a2ea2ff	78.720909	65.864198
12402c1bb76-69b3-4848-8a4f-2bace7db50e5	72.500000	61.943953

In the above table, each student has an average final ministry exam result and an average summative assessment score. The researcher ran the same functions to find out Pearson and Spearman correlation coefficients that were used earlier.

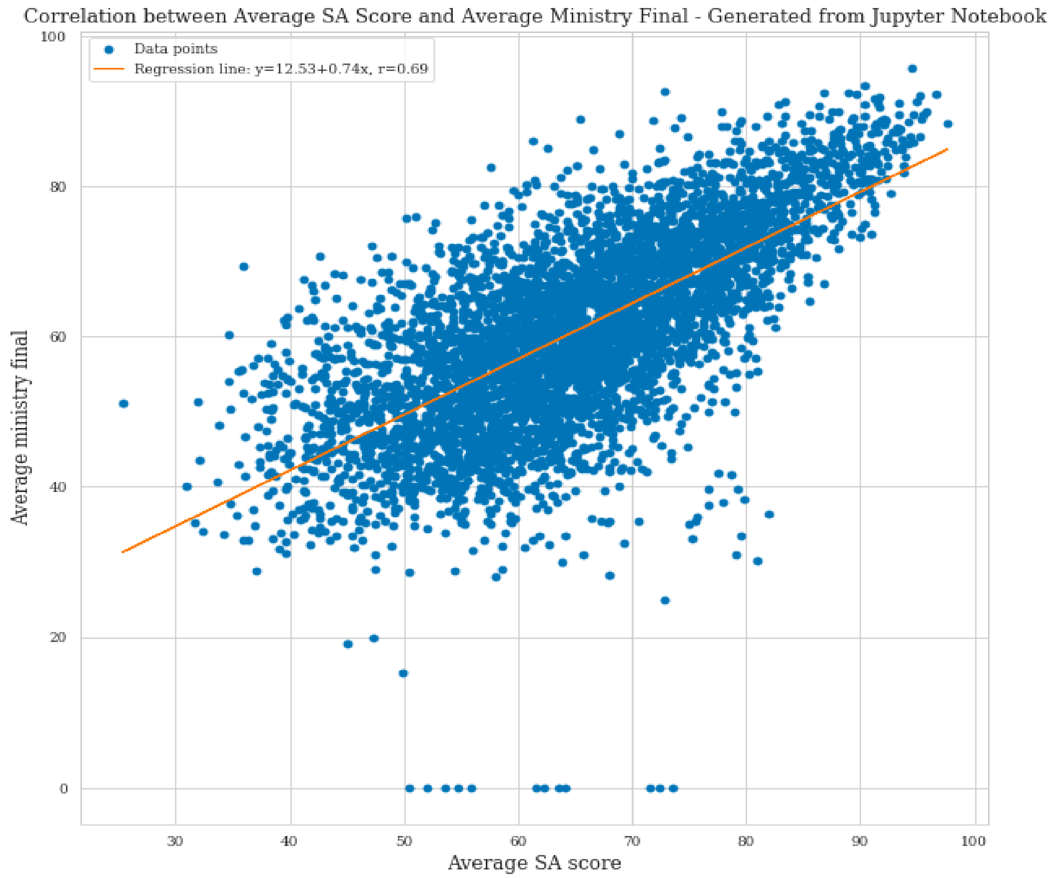
The output of applying the Pearson and Spearman correlation coefficient:

```
In [40]: stats.pearsonr(ministry['average_final'], ministry['avg_SA'])
Out[40]: (0.6914088556953869, 0.0)

In [41]: stats.spearmanr(ministry['average_final'], ministry['avg_SA'])
Out[41]: SpearmanrResult(correlation=0.7021418256939431, pvalue=0.0)
```

This output indicates that the Person correlation coefficient is 0.69, the Spearman correlation coefficient is 0.7, and the p-value is zero.

The graph below shows the data point and the regression line where the X-axis is the average of the summative assessment score, and the Y-axis is the average of the ministry final exam result. This graph shows that the line of correlation is steep, and the correlation coefficients for both Pearson and Spearman are around 0.7, and the p-value is 0. The relationship between the MOE exam scores and the Alef summative assessment scores is a positive correlation, and since the p-value is very low, this correlation is statistically significant. As one of these two assessments (SA scores or the MOE final score) increases, the other should also increase. The correlation coefficients are high, and the p-value is 0, proving that there is a statistically significant strong and positive correlation between the average summative assessment score and the average final exam score.

Figure 4. 2 Regression plot for average summative assessment (SA) score and Ministry final score



4.1.4.1.3 The relationship between the time spent on Alef Platform and the MOE's final exam result

The objective of this section is to understand the extent to which there is a correlation between the time spent on the Alef Platform and the final ministry exam result.

As explained above, the average time per breadcrumb column/stage per student on the Alef Platform data and the average final ministry exam score per student as well. Combining these two columns provides a data frame with the average time on Alef and the average final ministry exam score for each student, as shown in Table 4.10 below.

Table 4. 10 Combining students score in the final exam and time spent per stage

student_school_id	average_final	avg_breadcrumb_time
12400277183-f035-4a74-a03b-99bfdc244ae6	78.395455	57.416477
124011d7e1c-b6fa-487b-a688-cee794b273da	50.820000	34.311989
124018326e8-2101-463f-89e3-1118b0119694	82.915833	78.917391
12402504826-ddb9-45b2-8b11-a85e8a2ea2ff	78.720909	52.257633
12402c1bb76-69b3-4848-8a4f-2bace7db50e5	72.500000	45.880499

Calculated the Spearman and Pearson correlation coefficients for the average of ministry final exams and the average time spent per stage on the Alef Platform by running the same functions for Pearson and Spearman correlation coefficients used earlier. The output of applying the Pearson and Spearman correlation coefficient is shown as below:

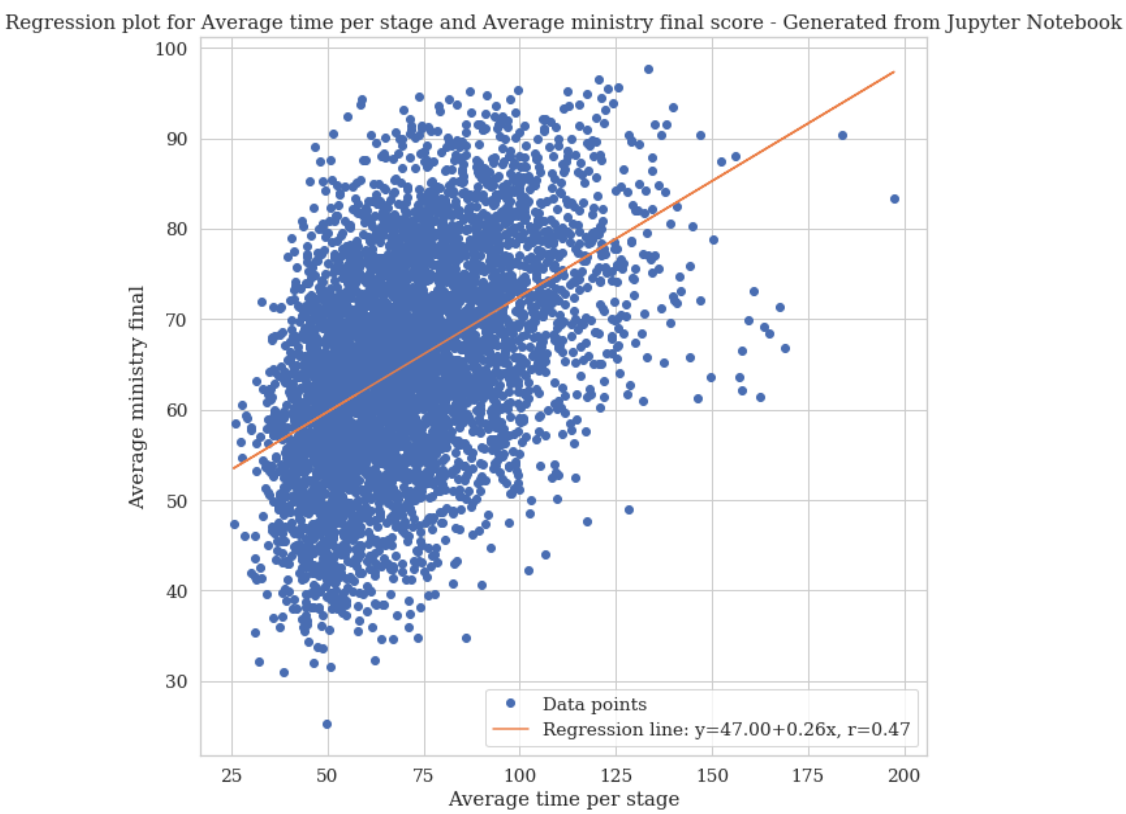
```
In [53]: stats.pearsonr(ministry_t['average_final'], ministry_t['avg_breadcrumb_time'])
Out[53]: (0.3975960503433963, 1.776114437184481e-193)

In [54]: stats.spearmanr(ministry_t['average_final'], ministry_t['avg_breadcrumb_time'])
Out[54]: SpearmanrResult(correlation=0.4764691369095882, pvalue=1.7518373038824394e-288)
```

This result shows that the correlation coefficient is about 0.4 for Pearson and 0.5 for Spearman. The low p-values (1.75 * 10^ -288 approximates symbol to 0) mean that the correlation results are statistically significant. The correlation shows that the average final score in the ministry exam is moderately positively correlated to the average stage time spent in the Alef Platform. This means that students who spent more time on the Alef Platform got better marks in the MOE final exam.

The graph below shows the data point and the regression line where the X-axis is the average of the ministry final exam score and the Y-axis is the average of time spent on the Alef Platform. This graph shows that the line of correlation is steep, and the correlation coefficients for both

Pearson and Spearman are around 0.4, and the p-value is almost 0. The relationship between the ministry exam scores and the time spent on the Alef Platform is a positive correlation, and since the p-value is very low, this correlation is statistically significant. As one of these two, the time spent on the Alef Platform or Ministry final score increases, the other also increases. The correlation coefficients are high, and the p-value is 0, so there is a statistically significant strong positive correlation between the time spent on the Alef Platform and the ministry's final exams score. This shows that the Alef Platform has impacted students' performance positively.

Figure 4. 3 Regression plot for average time per stage and average MoE final score



The above analytical data denotes a positive correlation between the time spent on the Alef Platform and the MoE final exam results. However, the graph shows anomalies that represent a few students who use the platform for a long time, yet they cannot achieve the expected result. It is possible that these students may have learning difficulties, or they lack the basic required skills.

4.1.4.1.4 Comparing between two groups of schools in students' performance:

This section presents the results of comparing students' performance between students in a group of schools that started to implement the Alef Platform 2018 and students in a group of schools that started to implement the Alef Platform in 2019. This comparison used the results of the Ministry of Education's final exam, the summative assessment on the Alef Platform and the diagnostic test results.

To make this comparison, the researcher used hypothesis testing, where the Mann-Whitney U test is used for this hypothesis test.

In this analysis, the researcher conducted the hypothesis tests based on a 95% confidence interval. So, the alpha value is 5%.

When the p-value is not less than alpha (0.05), that means the researcher cannot reject the null hypothesis. There is no sufficient evidence to say that there is a difference between the two groups.

When the p-value is less than alpha (0.05), the researcher can reject the null hypothesis. There is sufficient evidence to say that there is a difference between the two groups.

4.1.4.1.4.1 Ministry of Education's final exam

This section presents the difference in MOE students' final exam results between the 2018 and 2019 groups of schools.

To find an answer to the above question, the researcher compared the average of the student results in the ministry final exam between the two groups of schools that started to implement the Alef Platform in 2018 and the second group of schools that started to implement the Alef Platform 2019 the table below shows how the ministry data looks like. FIN column is the final ministry exam score. The researcher compared the exam result data between the two groups for three different subjects: science, mathematics, and English. The researcher decided to use the exam result data at term 1 because term 3 data is not an accurate representation because of the COVID-19 pandemic.

Table 4. 11 Final MoE exam score

student_id	subject_gen_subject	grade_name	FIN	Pass_Fail	Year	SCHOOLID
7945fc5a-74d4-4e19-b9d5-dd660ccb11ef	Arabic	9	97.11	1.0	2020	482
7945fc5a-74d4-4e19-b9d5-dd660ccb11ef	Biology	9	90.36	1.0	2020	482
7945fc5a-74d4-4e19-b9d5-dd660ccb11ef	Social Studies	9	95.65	1.0	2020	482
7945fc5a-74d4-4e19-b9d5-dd660ccb11ef	Islamic Studies	9	95.57	1.0	2020	482
7945fc5a-74d4-4e19-b9d5-dd660ccb11ef	Physics	9	93.60	1.0	2020	482

The researcher conducted the Mann-Whitney U test on the average of the ministry final exam results in 2018 and 2019 Alef schools for term 1 in the 2019/2020 academic year for Science, Mathematics and English language.

4.1.4.1.4.1.1 Science Ministry exam

The statistics below show the Mann-Whitney U test output for the final exam score in 2018 and 2019 Alef schools for term 1 in the 2019/2020 academic year for Science.

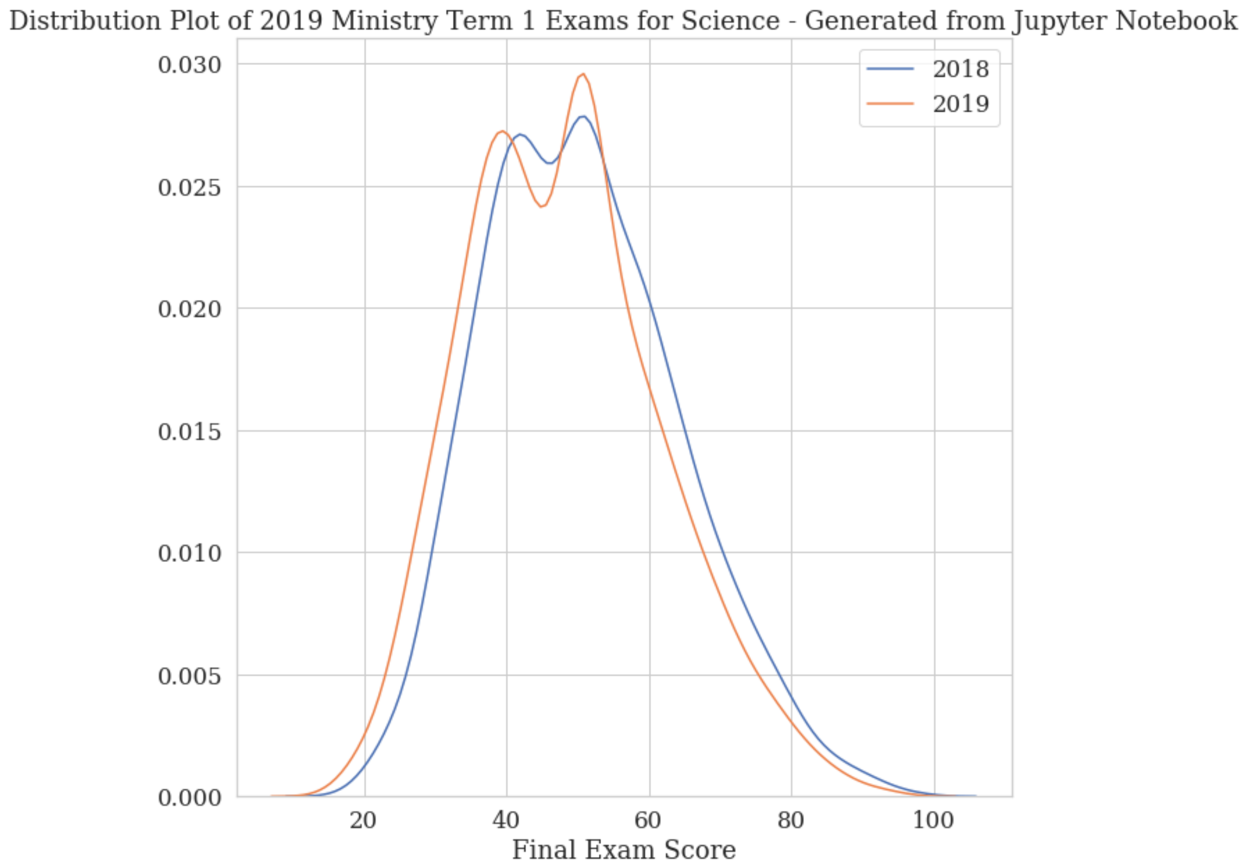
```
Statistics = 3615387.0, p = 8.445288354560095e-12.
The CLES is 0.4456363137887001
Since p < aplha : Greater (reject H0)
```

The output above shows that the p-value is less than 0.05; hence we can claim over a 95% confidence interval that 2018 schools have a greater average ministry final Science exam results than 2019 schools.

The CLES is the common language effect size. It looks at the total number of ordered pairs possible for the ministry final Science exam results between the two groups of 2018 and 2019 schools. The CLES output above is 0.45; this means that for 45% of the total number of ordered pairs possible, the student from the 2018 schools group has greater ministry final Science exam results than the student from the 2019 schools' group.

Figure 4.4 below shows the plot of distributions of the Science scores in the Ministry exam. The graph shows that the group 2018 had higher FIN (final) scores, the blue is above the red line, and 2018 students have more probability of getting better exam results. The result says that there is enough evidence to suggest that 2018 schools are performing better than 2019 schools in term 1.

Figure 4. 4 Distribution Plot of 2019 Ministry Term 1 Exams for Science



4.1.4.1.4.1.2 Mathematics Ministry exam

The statistics below show the Mann-Whitney U test output for the final exam score in 2018 and 2019 Alef schools for term 1 in the 2019/2020 academic year for Mathematics.

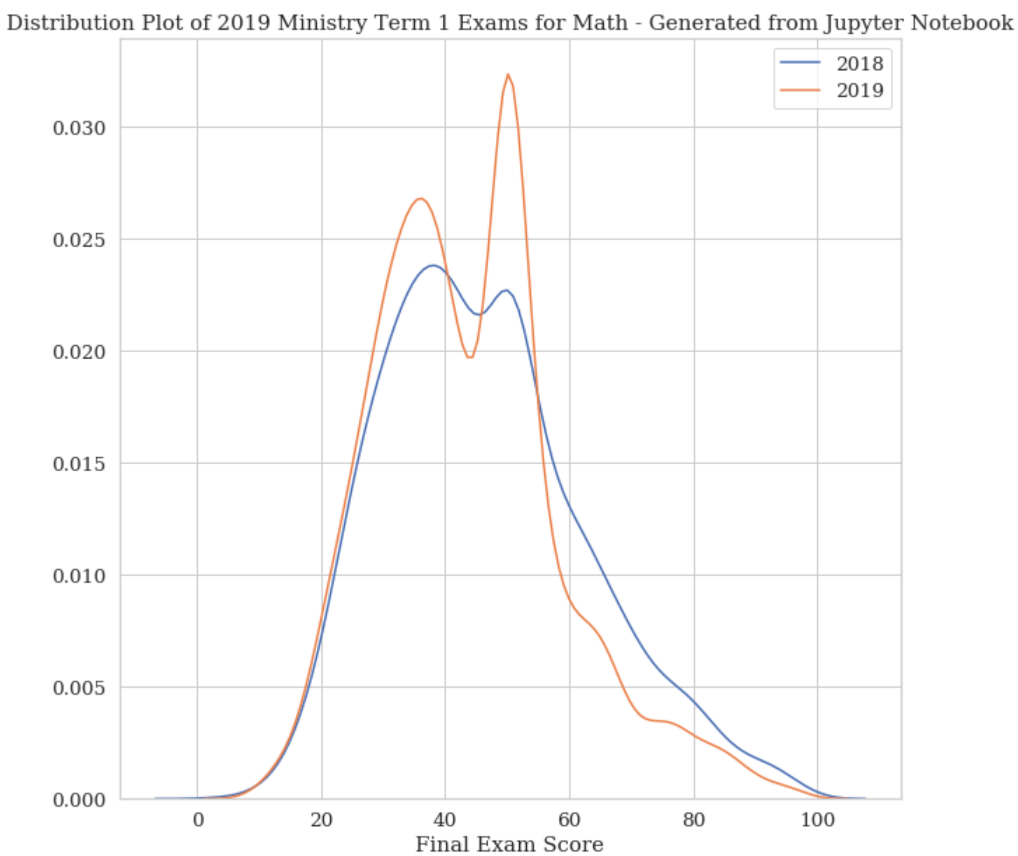
```
Statistics = 3527620.0, p = 2.024287776740526e-07.
The CLES is 0.4590940259638302
Since p < aplha : Greater (reject H0)
```

The results for the hypothesis again suggest that the students in group 2018 schools are performing greater in Math in term 1 of 2019-2020.

The CLES looks at the total number of ordered pairs possible for the final exam score between the two groups of 2018 and 2019 schools. The CLES in the output above is 0.45; this means that for 45% of the total number of ordered pairs possible, the student from the 2018 schools group has a greater result in the final math exam than the student from the 2019 schools' group.

Figure 4.5 below shows the plot of distributions of the math scores in the Ministry exam. The graph shows that the group 2018 had higher scores; the blue is above the orange line on the right side where the grade higher, and 2018 students have more probability of getting better exam results. The result says that there is enough evidence to suggest that 2018 schools are performing better than 2019 schools in math exams in term 1.

Figure 4. 5 Distribution Plot of 2019 Ministry Term 1 Exams for Math



4.1.4.1.4.1.3 English language Ministry exam

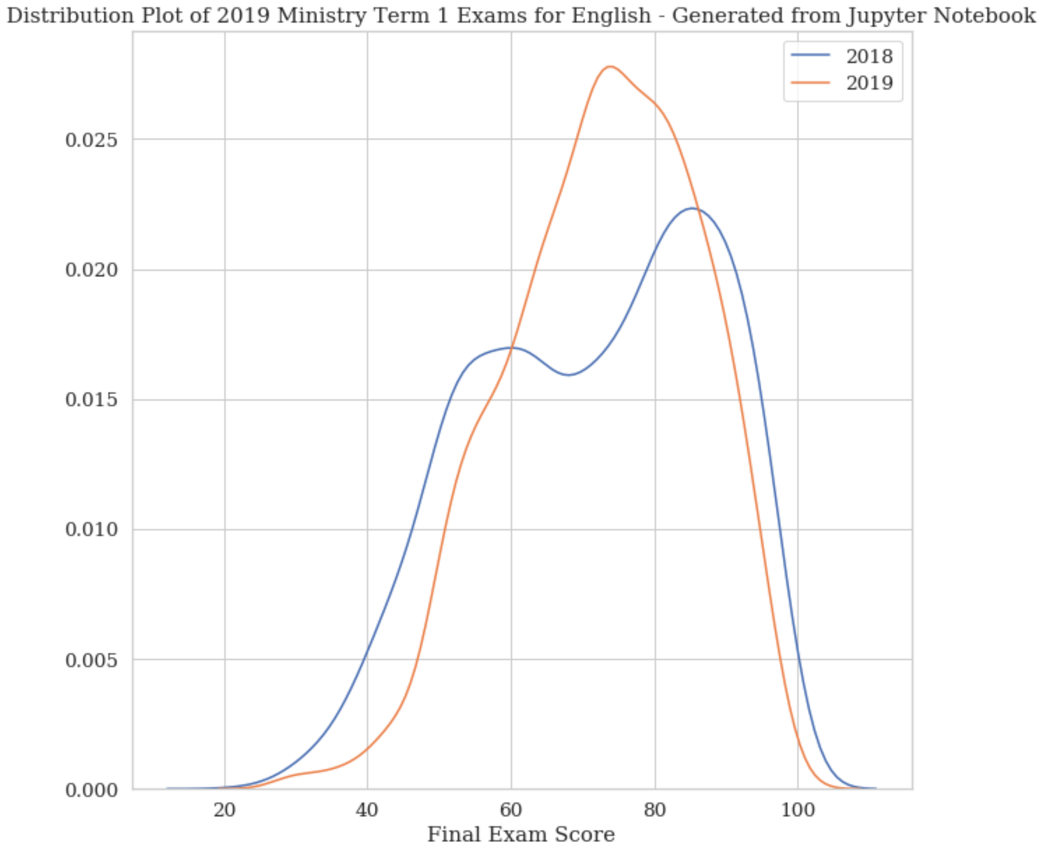
The statistics below show the Mann-Whitney U test output for the final exam score in 2018 and 2019 Alef schools for term 1 in the 2019/2020 academic year for the English language subject.

```
Statistics = 3175631.0, p = 0.10581559156209401.
The CLES is 0.5130660957715242
Since p > alpha : Same distribution (fail to reject H0)
```

For English, the result of the hypothesis claims that the distribution of both 2018 and 2019 schools scores are similar. This could imply that students are doing better in subjects like Math and Science by using the digital learning platform, and their performance in subjects like English might not be as much affected by how long they have been using the Alef Platform.

Figure 4.6 below shows the plot of distributions of the English scores in the Ministry exam. The graph shows that the group 2018 had higher scores; the blue is above the orange line in the right side where the grade higher, and 2018 students have more probability of getting better exam results. The result indicates that there is enough evidence to suggest that 2018 schools are performing better than 2019 schools in the English exam in term 1.

Figure 4. 6 Distribution Plot of 2019 Ministry Term 1 Exams for English



4.1.4.1.4.2 Summative Assessment on Alef Platform

This part explores the extent to which there is a difference in summative assessment results between the two 2018 and 2019 groups of schools.

In order to address this question, the researcher compared the average of the student results in the summative assessment on the Alef Platform between the two groups of schools that started to implement the Alef Platform in 2018 and the second group of schools that started to implement the Alef Platform in 2019. So, the researcher conducted the Mann-Whitney U test on the average summative assessment results on Alef data for the 2019-2020 school year.

The statistics below show the Mann-Whitney U test output for the summative assessment on the Alef Platform in 2018 and 2019 Alef schools for the 2019/2020 academic year.

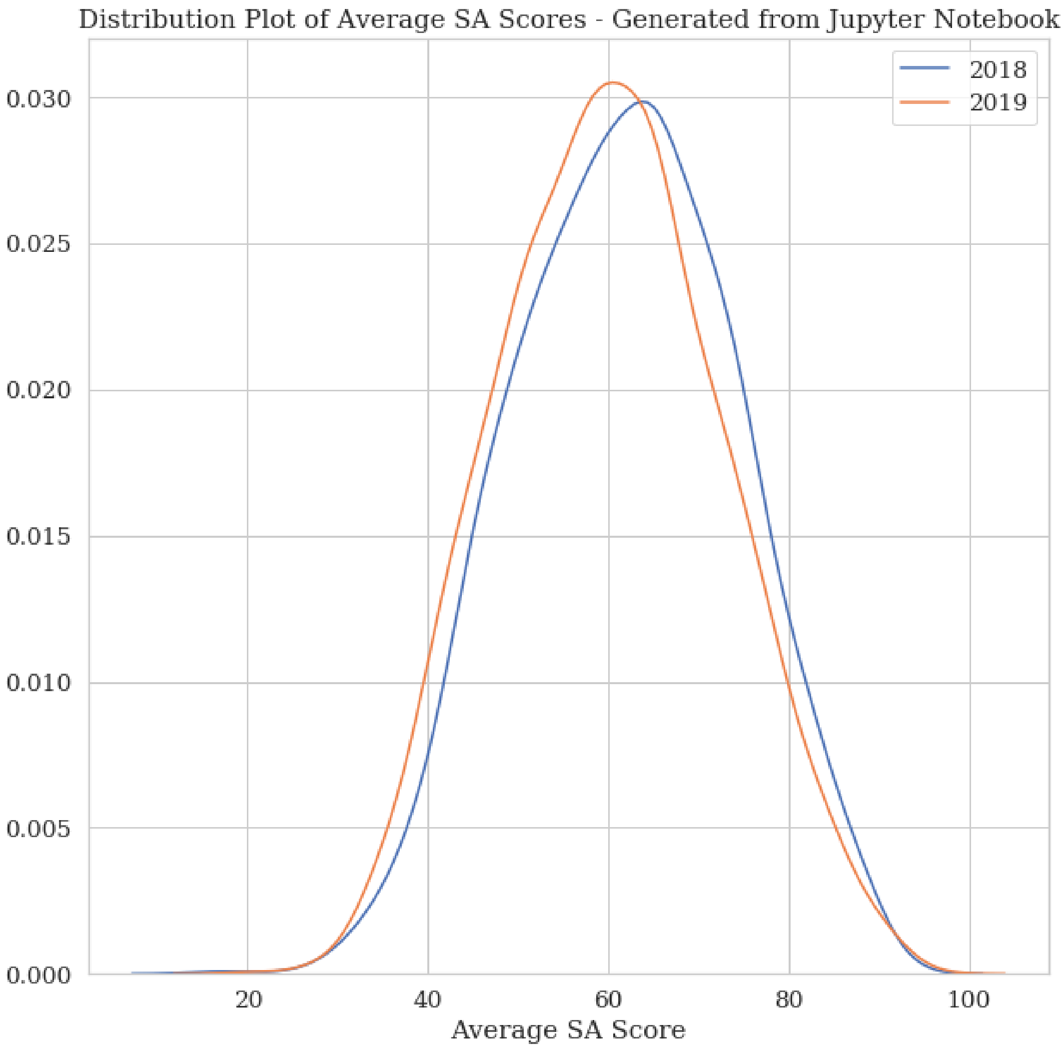
```
Statistics = 3607834.0, p = 1.821095050005061e-08.
The CLES is 0.45567500009052386
Since p < aplha : Greater (reject H0)
```

The output above shows that the p-value is less than 0.05; hence we can claim over a 95% confidence interval that 2018 schools have greater average summative assessment scores than 2019 schools.

The CLES looks at the total number of ordered pairs possible for the summative assessment scores between the two groups of 2018 and 2019 schools. The CLES in the output above is 0.45; this means that for 45% of the total number of ordered pairs possible, the student from the 2018 schools group has a greater summative assessment score than the student from the 2019 schools' group.

The plot below (Figure 4.7) shows that the highest probability density (y-axis) of average_SA (summative assessment) is at a higher score for 2018 schools (that is blue) than 2019 (that is in orange colour). This result supports the hypothesis that students in 2018 schools have higher average summative assessment scores.

Figure 4. 7 Distribution Plot of average SA score



4.1.4.1.4.3 Diagnostic test results

This section explores the extent to which there is a difference in diagnostic tests between students who started with the Alef platform in 2018 and students who started in 2019.

In order to address this question, the researcher compared the average of the diagnostic tests data between the two groups of schools that started to implement the Alef Platform in 2018 and the second group of schools that started to implement the Alef Platform 2019. The table below shows several select rows from the diagnostic tests data frame, in order to highlight the results. In order to highlight results.

Table 4. 12 Average of diagnostic test

school_dw_id	student_id	SS	Language	Reading	Science
180	3389b620-b296-4de8-924c-acd78dc66989	617	189.0	164.0	186.0
180	6ea1c542-097f-4401-bc31-aeb8625c0cf7	759	197.0	181.0	211.0
6	e2fcafee-2ca7-4b6d-be6f-8759df0d5b2e	562	168.0	NaN	173.0
332	aa3d2014-2fdb-42b5-af50-571106639778	673	173.0	168.0	176.0
332	5062be2e-6874-49b9-a351-6338e9bd736b	552	186.0	175.0	182.0

The diagnostic test data includes the scores for four different kinds of diagnostic tests. SS is for a math diagnostic test score, and the other types (Language, Reading, Science) are self-explanatory.

The researcher extracted the rows from the data frame for diagnostic tests for each group of schools (2018 and 2019) and then compared the distribution of scores for the two groups of schools to see if one group of scores was greater than the other. Then the researcher conducted the Mann-Whitney U test on the average of the diagnostic test result in 2018 and 2019 Alef schools in the 2019/2020 academic year for Language, Reading, Science and Mathematics.

4.1.4.1.4.3.1 Math diagnostic test

The output below shows the result of the Mann-Whitney U test for the Math diagnostic test.

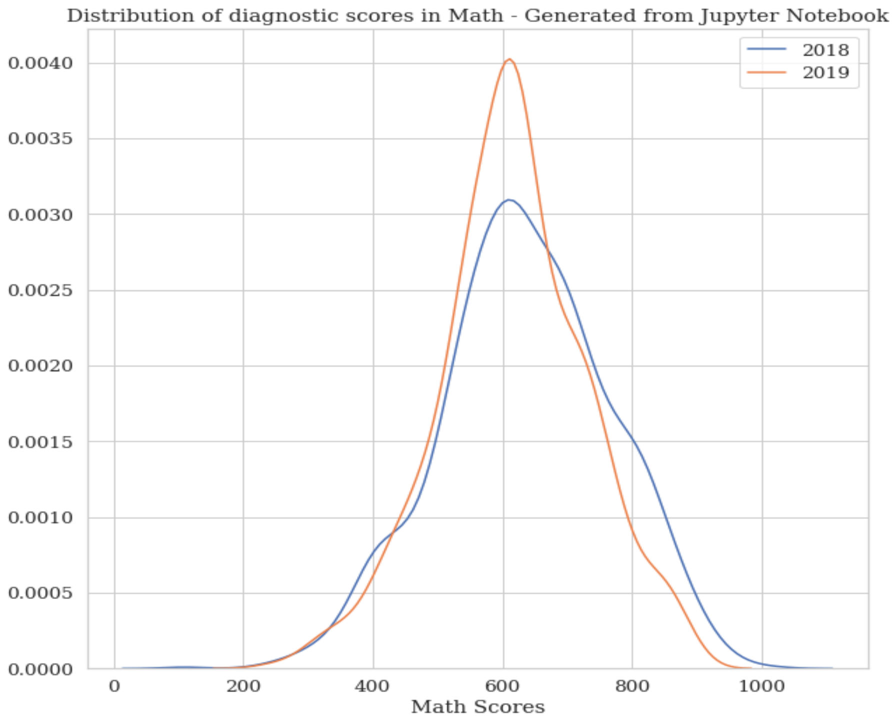
```
Statistics = 409837.0, p = 0.0006079584151933466.
The CLES is 0.45267275376370364
Since p < aplha : Greater (reject H0)
```

The p-value is less than 0.05, so there is evidence to reject the null hypothesis (i.e. reject that the distribution of diagnostic scores is the same for 2018 and 2019 schools) and conclude that there is enough evidence over a 95% confidence interval to suggest that the SS (Math) diagnostic test scores are greater for 2018 than 2019 schools.

The CLES is the common language effect size. It looks at the total number of ordered pairs possible for the SS (Math) diagnostic test scores between the two groups of 2018 and 2019 schools. The CLES above is 0.45; this means that for 45% of the total number of ordered pairs possible, the student from the 2018 schools group has a greater SS (Math) diagnostic score than the student from the 2019 schools' group.

The plot below (Figure 4.8) shows the distribution of SS (Math) diagnostic scores. The y-axis is the probability density function. The plot below shows that SS scores higher where the blue line, which presents the 2018 schools' group, is above the orange line, which presents the 2019 schools' group. This shows a higher probability densities for 2018 schools for higher SS diagnostic scores. Similarly, the 2019 schools' students have a higher probability density for lower SS scores. Hence, the hypothesis test and this plot show something similar: the 2018 group of school students score better in the SS diagnostic test when compared to the 2019 group of school students.

Figure 4. 8 Distribution Plot of diagnostic scores in Math



4.1.4.1.4.3.2 Language diagnostic test

The researcher repeated the previous steps of analysis for the Language diagnostic test. The output below shows the result of the Mann-Whitney U test for the Language diagnostic test.

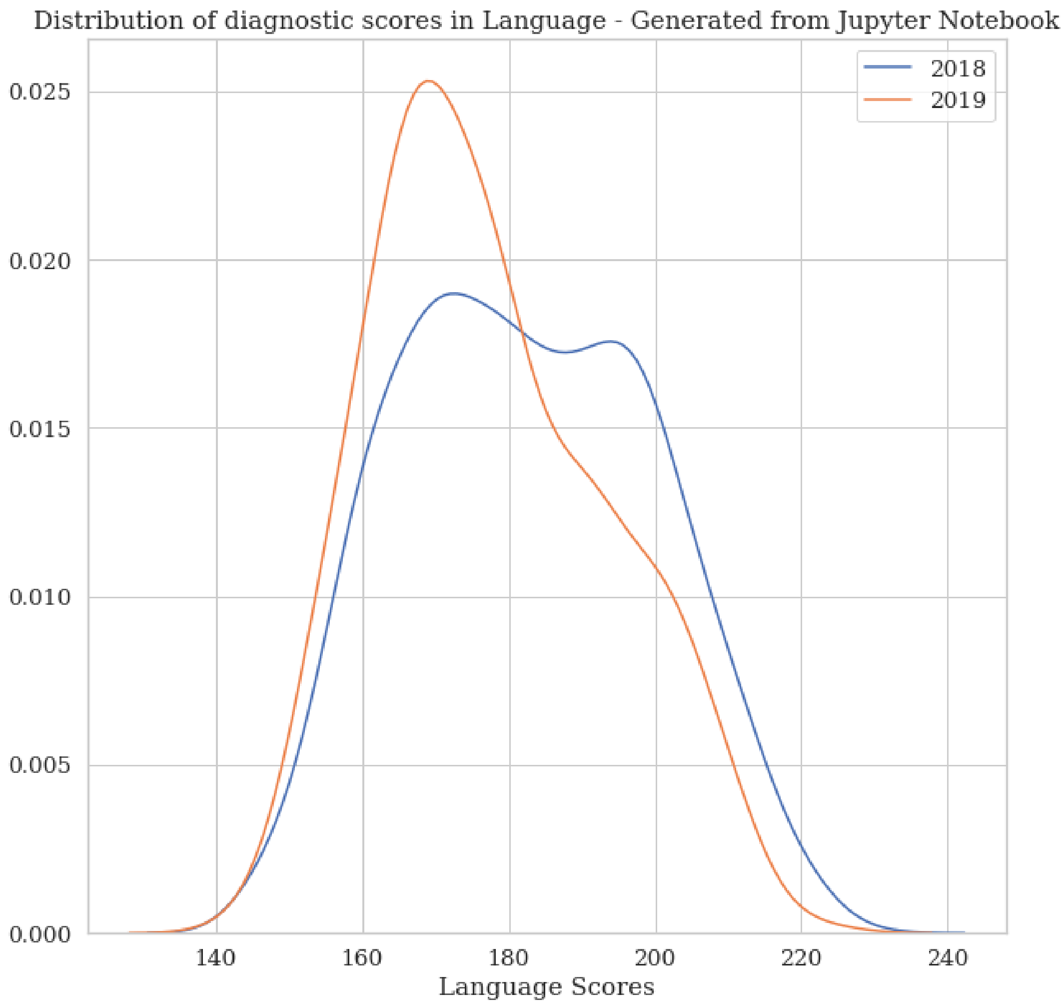
```
Statistics = 394291.0, p = 0.03467762115470523.
The CLES is 0.4734340548907114
Since p < aplha : Greater (reject H0)
```

The p-value is much less than 0.05 (alpha value), so there is evidence to reject the null hypothesis (i.e. reject that the distribution of Language diagnostic test scores is the same for 2018 and 2019 schools) and suggest that there is enough evidence over a 95% confidence interval to suggest that the rLanguage diagnostic test scores are greater for 2018 than 2019 schools.

The CLES looks at the total number of ordered pairs possible for the Language diagnostic test scores between the two groups of 2018 and 2019 schools. The CLES above is 0.47; this means that for 47% of the total number of ordered pairs possible, the student from the 2018 schools group has a greater Language diagnostic score than the student from the 2019 schools' group.

The plot below (Figure 4.9) shows the distribution of Language diagnostic test scores. The y-axis is the probability density function. The plot below shows that Language diagnostic test scores are higher where the blue line, which presents the 2018 schools' group, is above the orange line, which presents the 2019 schools' group. This shows a higher probability densities for 2018 schools for higher Language diagnostic test scores. Similarly, the 2019 schools' students have higher probability density for lower Language diagnostic test scores. Hence, the hypothesis test and this plot show something similar: the 2018 group of school students score better in the Language diagnostic test when compared to the 2019 group of school students.

Figure 4. 9 Distribution Plot of diagnostic scores in Language



4.1.4.1.4.3.3 Reading diagnostic test

The researcher conducted the same previous steps of analysis for the Reading diagnostic scores.

The output below shows the result of the Mann-Whitney U test for the Reading diagnostic test.

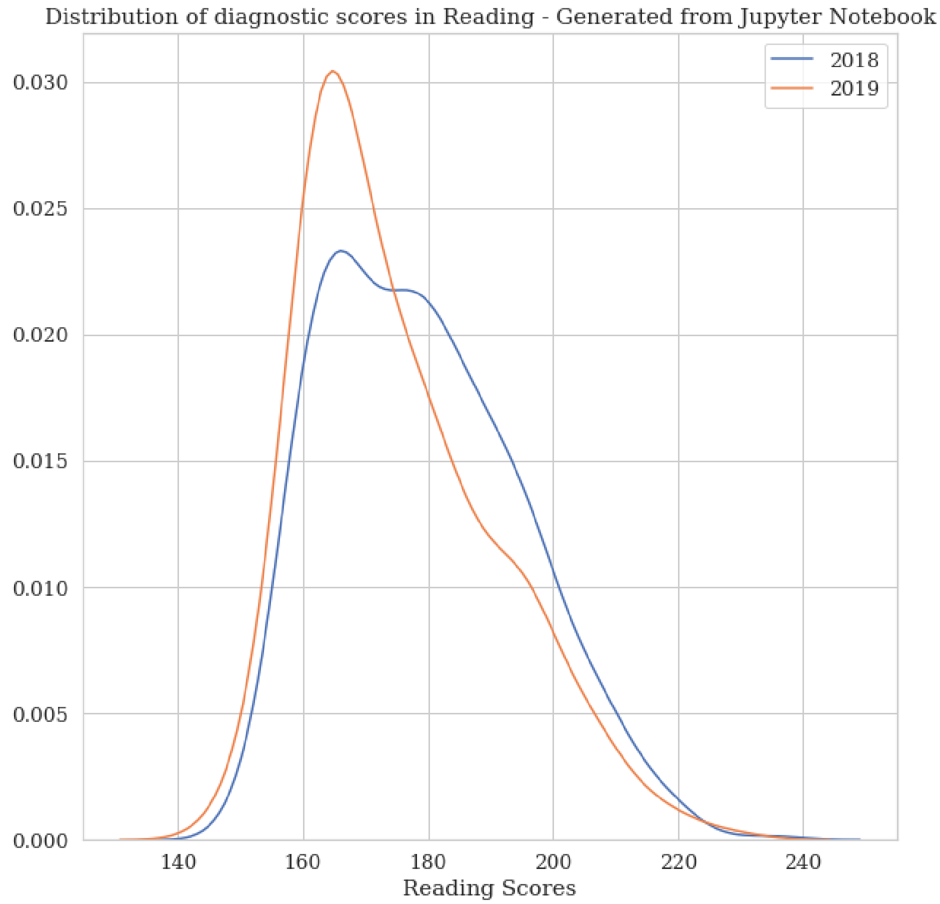
```
Statistics = 413654.5, p = 0.0001691224205568293.
The CLES is 0.44757457628703107
Since p < aplha : Greater (reject H0)
```

The p-value is much less than 0.05 (alpha value), so there is evidence to reject the null hypothesis (i.e. reject that the distribution of Reading diagnostic test scores is the same for 2018 and 2019 schools) and suggest that there is enough evidence over a 95% confidence interval to suggest that the reading diagnostic test scores are greater for 2018 than 2019 schools.

The CLES looks at the total number of ordered pairs possible for the Reading diagnostic test scores between the two groups of 2018 and 2019 schools. The CLES above is 0.44; this means that for 44% of the total number of ordered pairs possible, the student from the 2018 schools group has a greater Reading diagnostic test score than the student from the 2019 schools' group.

Figure 4.10 below shows the distribution of Reading diagnostic test scores. The y-axis is the probability density function. The plot below shows that Reading diagnostic test scores are higher where the blue line, which presents the 2018 schools' group, is above the orange line, which presents the 2019 schools' group. This shows a higher probability density for 2018 schools for a higher Reading diagnostic test score. Similarly, the 2019 schools' students have higher probability density for a lower Reading diagnostic test score. Hence, the hypothesis test and this plot shows something similar: the 2018 group of school students score better in the Reading diagnostic test score when compared to the 2019 group of school students.

Figure 4. 10 Distribution Plot of diagnostic scores in Reading



4.1.4.1.4.3.4 Science Diagnostic test

The researcher conducted the same previous steps of analysis for Science diagnostic test scores. The output below shows the result of the Mann-Whitney U test for Science diagnostic test scores.

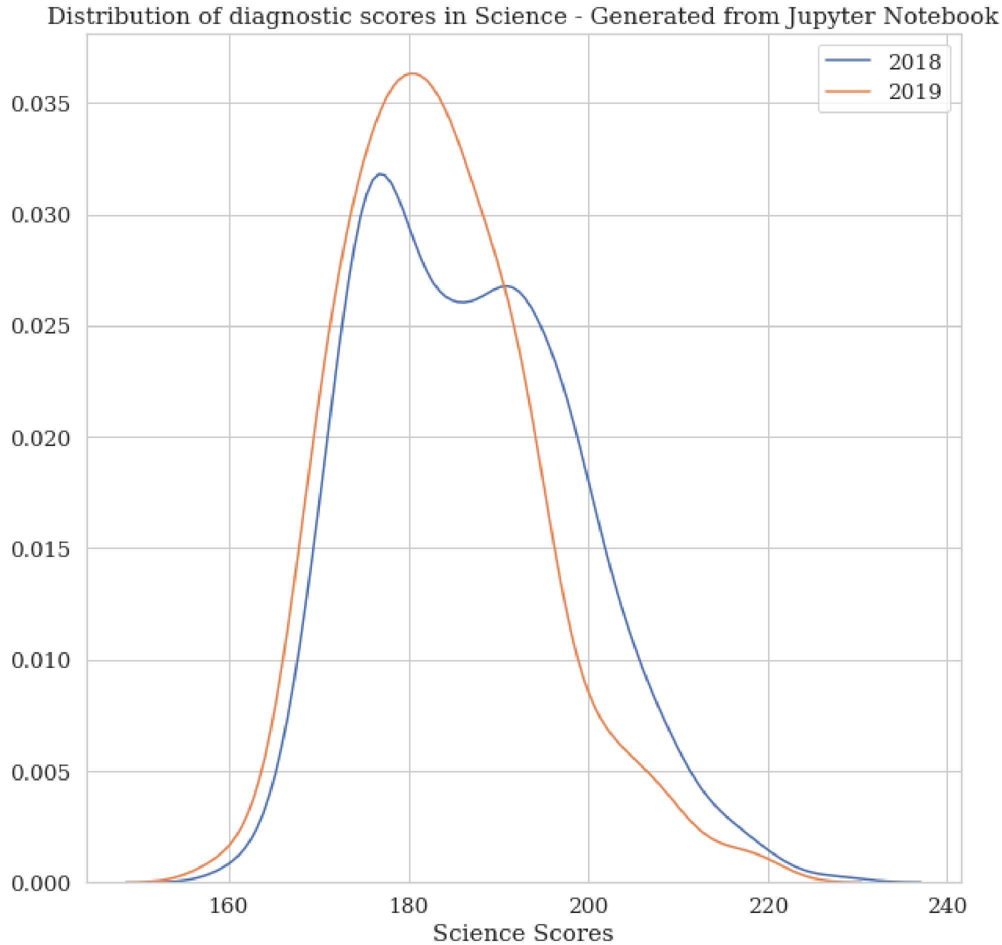
```
Statistics = 434010.0, p = 2.6131088239951572e-08.
The CLES is 0.42039030605090566
Since p < aplha : Greater (reject H0)
```

The p-value is much less than 0.05 (alpha value), so there is evidence to reject the null hypothesis (i.e. reject that the distribution of Science diagnostic test scores is the same for 2018 and 2019 schools) and suggest that there is enough evidence over a 95% confidence interval to suggest that the reading diagnostic test scores are greater for 2018 than 2019 schools.

The CLES looks at the total number of ordered pairs possible for the Science diagnostic test scores between the two groups of 2018 and 2019 schools. The CLES above is 0.43; this means that for 43% of the total number of ordered pairs possible, the student from the 2018 schools group has a greater Science diagnostic test score than the student from the 2019 schools' group.

The plot below (Figure 4.11) shows the distribution of Science diagnostic test scores. The y-axis is the probability density function. The plot below shows that Science diagnostic test scores are higher where the blue line, which presents the 2018 schools' group, is above the orange line, which presents the 2019 schools' group. This shows a higher probability densities for 2018 schools for higher Science diagnostic test scores. Similarly, the 2019 schools' students have higher probability density for lower Science diagnostic test scores. Hence, the hypothesis test and this plot show something similar: the 2018 group of school students score better in the Science diagnostic test scores when compared to the 2019 group of school students.

Figure 4. 11 Distribution Plot of diagnostic scores in Science



Overall, the analysis of the different types of diagnostic test scores indicates that there is a significant statistical difference between 2018 students and 2019 students, specifically that the 2018 students have greater diagnostic test scores in all kinds of diagnostic tests.

4.1.4.1.5 Student engagement with AI-powered learning Platforms

This section presents all data analysis related to students' engagement with the Alef Platform.

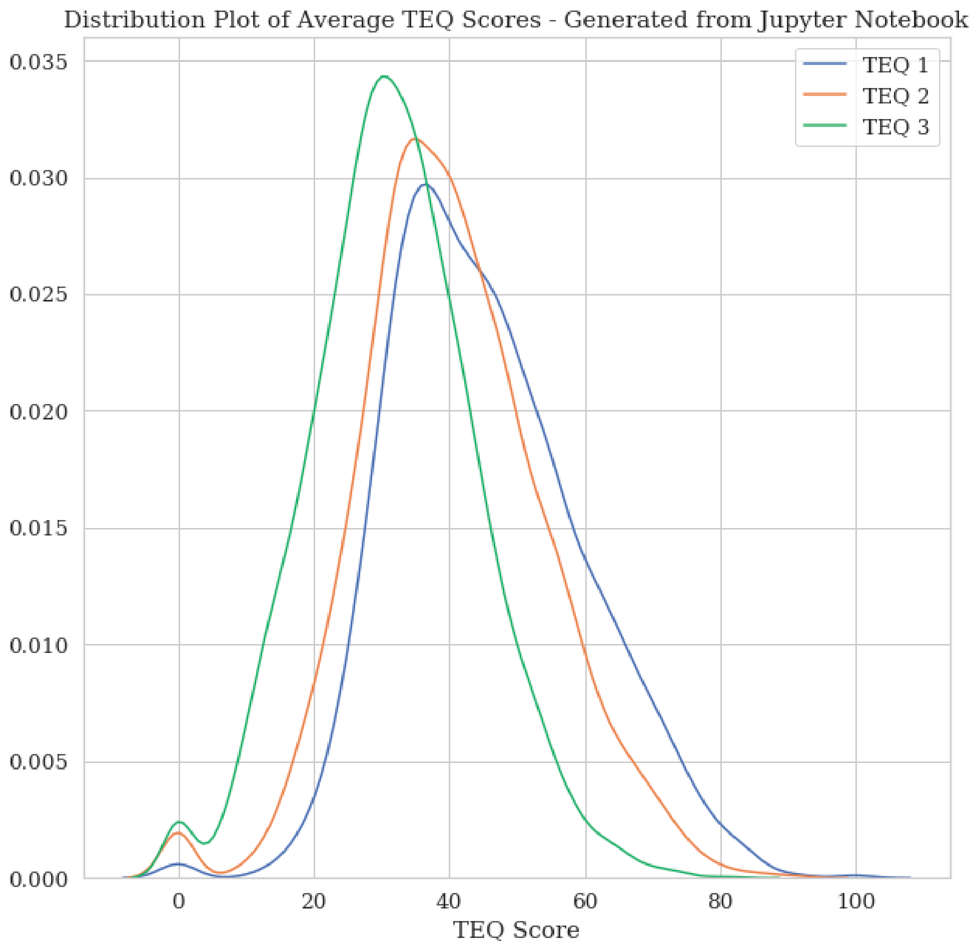
4.1.4.1.5.1 Formative assessment

As shown previously in the introduction of this chapter in Table 5.5, one of the breadcrumbs/stages included is “Check My Understanding”. The metric used in this part is the average of Check my Understanding (TEQ) that follows each piece of learning material as a formative assessment in each lesson for the 2019-2020 school year.

In this section of the analysis, the average Check my Understanding TEQ score (TEQ 1, 2, and 3) is calculated for each student for the entire school year.

Figure 5.12 below shows how the probability densities of the three TEQ scores are. The x-axis represents the TEQ score, and the y-axis represents the probability density of achieving that score. The graph presents the three plots for TEQ 1, which is shown in blue colour, TEQ 2, which is shown in orange colour, and TEQ 3, which is shown in green colour. As the TEQs progress, the plot shifts to the left. This is due to the fact that as the lesson progresses, students dive into different stages of the depth of knowledge (DOK), the TEQs become harder for the student, so students spend more time in TEQ 2 and TEQ 3 than in TEQ 1.

Figure 4. 12 Distribution Plot of average TEQs scores



The researcher conducted the Pearson and Spearman correlation coefficients for the average time spent on TEQ and the average TEQ score in order to find the relationship between student engagement with the formative assessment (average time spent) and their TEQ score.

4.1.4.1.5.1.1 Formative assessment 1 (TEQ 1)

The below output shows the results of the Pearson and Spearman correlation coefficients for the average time spent on TEQ 1 and the average TEQ 1 score.

```
stats.pearsonr(p['teq1'], p['time1'])
```

```
(0.38972445077094175, 1.8254718439260252e-186)
```

```
stats.spearmanr(p['teq1'], p['time1'])
```

```
SpearmanrResult(correlation=0.6116069837293155, pvalue=0.0)
```

The output above indicates that the Pearson correlation coefficient is 0.39 and the Spearman correlation coefficient is 0.61, and the p-value is 0.

The correlation coefficient is positive, which denotes a positive relationship between the average of the formative assessment (TEQ 1) and the average time spent per student.

The results have a p-value of 0, and based on the explanation above, since the p-value is lower than 0.05, the correlation coefficients are statistically significant. Hence, the result is significant, meaning there exists a positive and moderately strong relationship between the average formative assessment (TEQ 1) score and the average time spent on it per student.

Figure 5.13 below shows the data point and regression line where the x-axis represents the average of time spent on the formative assessment (TEQ 1) per student, and the y-axis is the average of the formative assessment (TEQ 1) score. This plot is created using the linregress function in the stats module. It visually represents the correlation between the average formative assessment (TEQ 1) scores and the average time spent on it per student.

4.1.4.1.5.1.2 Formative assessment 2 (TEQ 2)

The output below shows the results of the Pearson and Spearman correlation coefficients for the average time spent on TEQ 2 and the average TEQ 2 score.

```
stats.pearsonr(p['teq2'], p['time2'])
```

```
(0.7108080425781431, 0.0)
```

```
stats.spearmanr(p['teq2'], p['time2'])
```

```
SpearmanrResult(correlation=0.7378552637439124, pvalue=0.0)
```

The output above indicates that the Person correlation coefficient is 0.71 and the Spearman correlation coefficient is 0.73 and that the p-value is zero.

The correlation coefficient is positive, which represents a positive relationship between the average formative assessment (TEQ 2) and the average time spent in the Alef platform lesson by each student. That means when students spend more time studying on the Alef platform, they will probably get a good score in the formative assessment.

The results have a p-value of 0 and based on the above explanation, since the p-value is lower than the 0.05, the correlation coefficients are statistically significant. Hence, the result is significant, which means there exists a positive and moderately strong relationship between the average formative assessment (TEQ2) score and the average time spent on it per student.

Figure 5.13 below shows the data point and regression line where the X-axis is the average of time spent on formative assessment (TEQ2) per student. And Y-axis is the average of the formative assessment (TEQ2) score. This plot is created using the Linregress function in the stats module. It visually represents the correlation between the average formative assessment (TEQ2) scores and the average time spent on it per student.

4.1.4.1.5.1.3 Formative assessment 3 (TEQ 3)

The output below shows the results of the Pearson and Spearman correlation coefficients for the average time spent on TEQ 2 and the average TEQ 2 score.

```
: stats.pearsonr(p['teq3'], p['time3'])

: (0.7487472402633333, 0.0)
```

```
stats.spearmanr(p['teq3'], p['time3'])

SpearmanrResult(correlation=0.7774234065978172, pvalue=0.0)
```

The output above indicates that the Person correlation coefficient is 0.75, and the Spearman correlation coefficient is 0.78, and the p-value is zero.

The correlation coefficient is positive, so this represents a positive relationship between the average formative assessment (TEQ 3) and the average time spent on each student.

The results have a p-value of 0, and based on the above explanation since the p-value is lower than 0.05, the correlation coefficients are statistically significant. Hence, the result is significant, and there exists a positive and moderately strong relationship between the average formative assessment (TEQ 3) score and the average time spent on it per student.

Figure 5.13 below shows the data point and regression line where the X-axis is the average time spent on formative assessment (TEQ 3) per student. Y-axis is the average of the formative assessment (TEQ 3) score. This plot is created using the linregress function in the stats module. It visually represents the correlation between the average formative assessment (TEQ 3) scores and the average time spent on it per student.

Figure 4.13 below shows the difference between the relationships of each TEQ's average scores with their respective average times.

Figure 4. 13 Regression Plot of average TEQs scores

4.1.4.5.2 Comparing students' engagement between the two groups of schools

The researcher conducted the Mann-Whitney U test to compare students' engagement in two independent groups of schools. The first group includes the schools that started implementing the Alef Platform in 2018 (group 2018), and the second group has the schools that started implementing the platform in 2019 (group 2019). This comparison enabled the researcher to gain a greater understanding of students' engagement with AI digital learning platforms. In order to find out if there is a difference in students' engagement between the students in each of the two groups, the researcher conducted the Mann-Whitney U test to compare the average time spent per stage on the Alef Platform in 2018 and 2019 Alef schools, and the average number of completed lessons.

4.1.4.6.2.1 Time spent on Alef Platform

This section explores the extent to which there is a difference in the average time spent on the Alef Platform between the two 2018 and 2019 groups of schools.

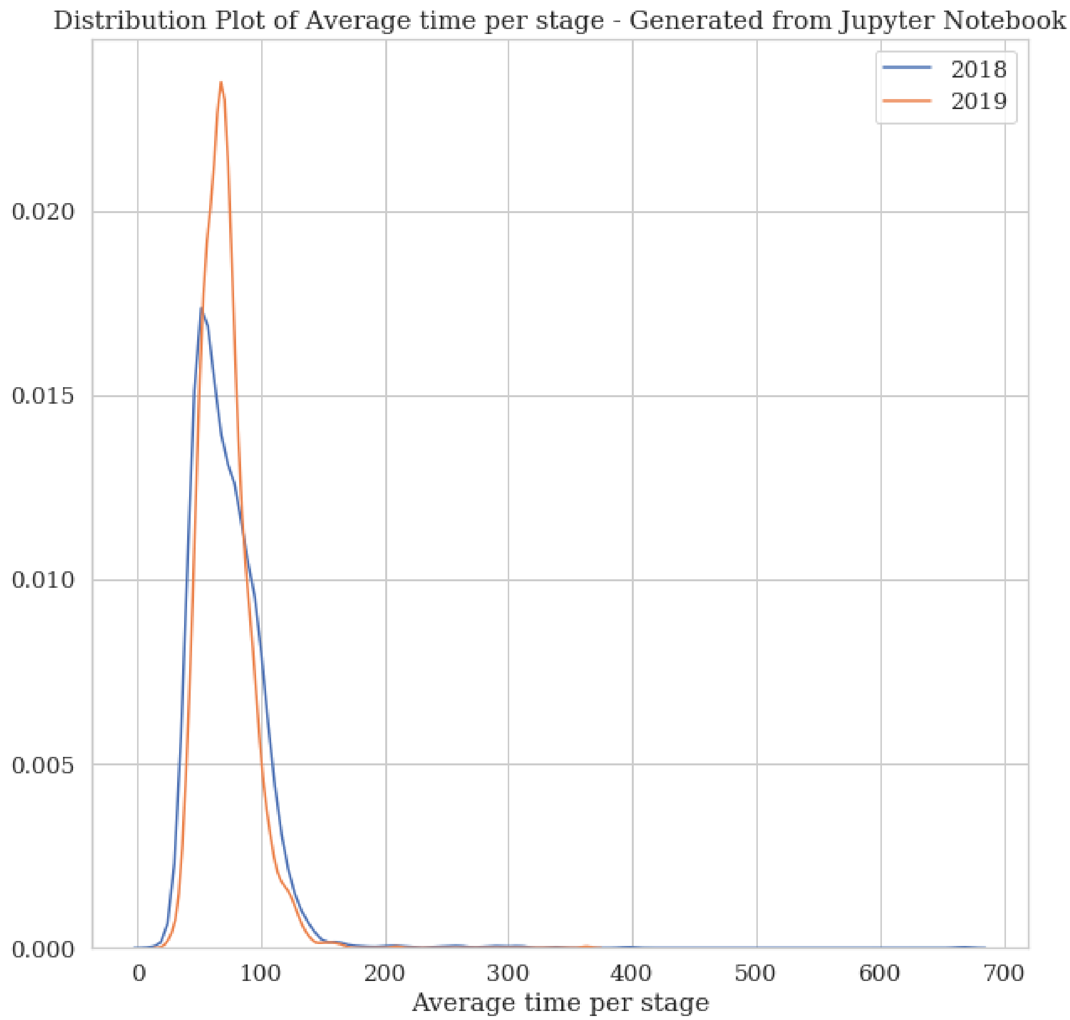
To find an answer to the above question, the researcher compared the average time spent on the Alef Platform between the two groups of schools. The researcher conducted the Mann-Whitney U test on the average time spent on the Alef Platform for the 2019-2020 school year.

The statistics below show the Mann-Whitney U test output for the average time spent on the Alef Platform in 2018 and 2019 Alef schools for the 2019/2020 academic year.

```
Statistics = 3271693.0, p = 0.4272522628506611.
The CLES is 0.5063896254847552
Since p > alpha : Same distribution (fail to reject H0)
```

As per the hypothesis test, and since the p-value is less than 0.5 (alpha), there is enough evidence to suggest that there is over a 95% confidence interval in the average time spent per stage on the Alef Platform that is similar for both 2018 and 2019 schools. The plot in Figure 4.14 shows that the two groups had similar average time spent per stage on the Alef Platform.

Figure 4. 14 Distribution Plot of average time spent per stage



4.1.4.6.2.2 Lessons completed on Alef Platform

This section explores the extent to which there is a difference in the number of lessons completed per student between the 2018 group and 2019 group.

To find an answer to the above question, the researcher compared the number of lessons completed per student on the Alef Platform between the two groups of schools. The researcher conducted the Mann-Whitney U test on each students' number of lessons completed for the 2019-2020 school year.

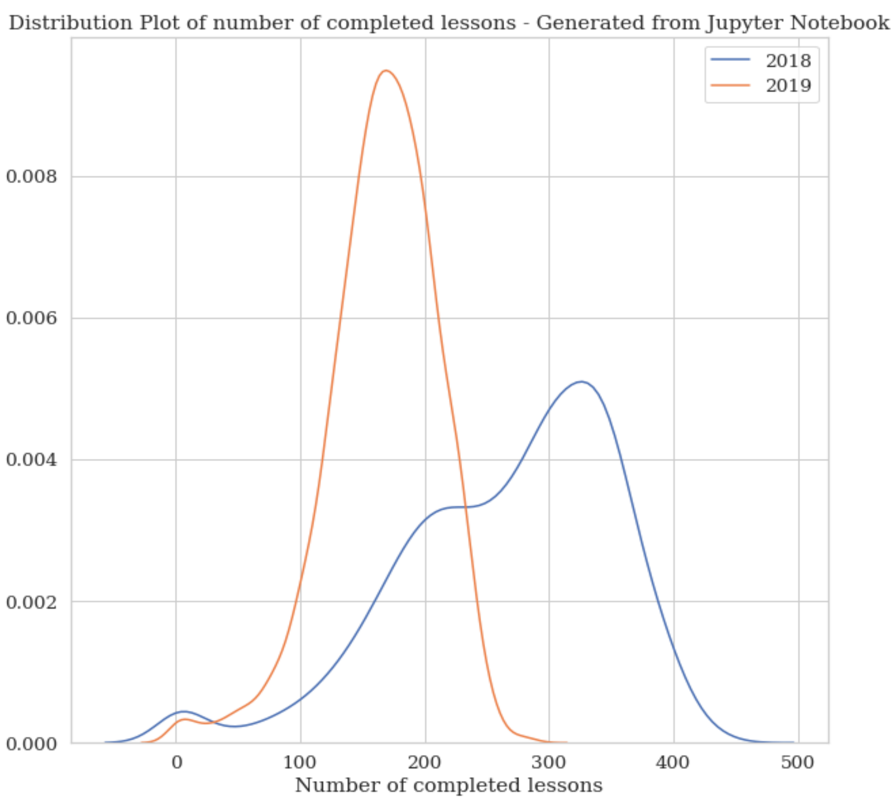
The output below shows the Mann-Whitney U test for the average number of lessons completed per student in 2018 and 2019 Alef schools for the 2019/2020 academic year.

```
Statistics = 5636073.5, p = 0.0.
The CLES is 0.14966827537594551
Since p < aplha : Greater (reject H0)
```

From the hypothesis test, the p-value is low and less than alpha; hence, there is evidence to reject the null hypothesis. There is enough evidence on a 95% confidence interval to suggest that the 2018 schools' students completed more lessons compared to 2019.

In Figure 4.15, the y-axis in the plot is the probability density function for the kernel density estimation; this is not the probability, but it is the probability density of any x value. Furthermore, the x-axis represents the range of the number of completed lessons.

Figure 4. 15 Distribution Plot of number of completed lessons



4.3.3 Comparison between boys and girls

This section explores the extent to which there is a difference in the average summative assessment score and time spent per student between boys and girls.

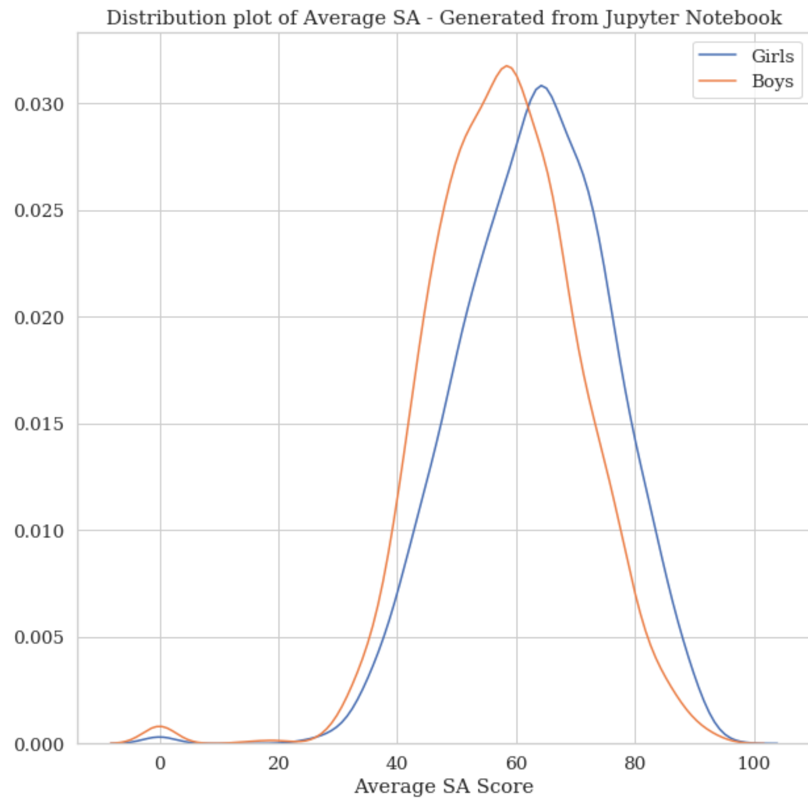
4.3.3.1 Summative Assessment Scores

The below statistics show the Mann-Whitney U test output for the hypothesis test to compare the average summative assessment scores distribution for girls vs boys.

```
Statistics = 4055191.0, p = 1.5051397180387958e-48.
The CLES is 0.3819350329243171
Since p < aplha : Greater (reject H0)
```

The p-value is $1.51 \times 10^{-48,}$ which is less than 0.05; hence there is enough evidence to suggest that the girls have a higher average summative assessment score than boys. The hypothesis test for the comparison of the average summative assessment scores distribution for girls vs boys on the Alef data resulted in the fact that it is statistically significant that girls score higher than boys. As shown in the below graph, the plot representing the girls is shifted to the right, indicating that they have higher scores.

Figure 4. 16 Distribution Plot of Average SA for Girls vs. Boys



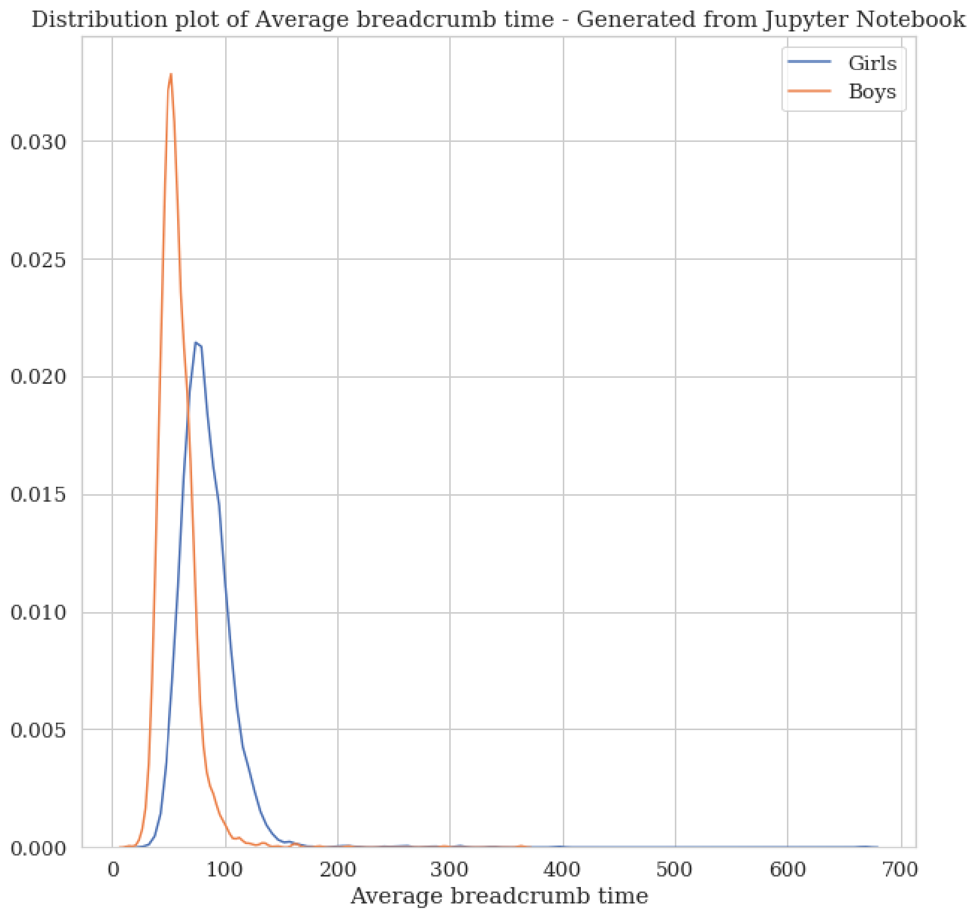
4.3.3.2 Average time per stage

The below statistics show the Mann-Whitney U test output for the hypothesis test to compare the distribution of girls vs boys on average time spent per stage.

```
Statistics = 5694116.0, p = 0.0.
The CLES is 0.1321410956807905
Since p < aplha : Greater (reject H0)
```

The p-value is less than 0.05; hence there is enough evidence to conclude that girls spend more time per stage than boys. The plot below shows the same since the girls' plot is shifted to the right. The hypothesis test for comparison of the distribution of girls vs boys' average breadcrumb time on the Alef data resulted in the fact that it is statistically significant that girls spend more time on the Alef platform per breadcrumb when compared to boys.

Figure 4. 17 Distribution Plot for Average Time Spent per Stage for Girls vs Boys



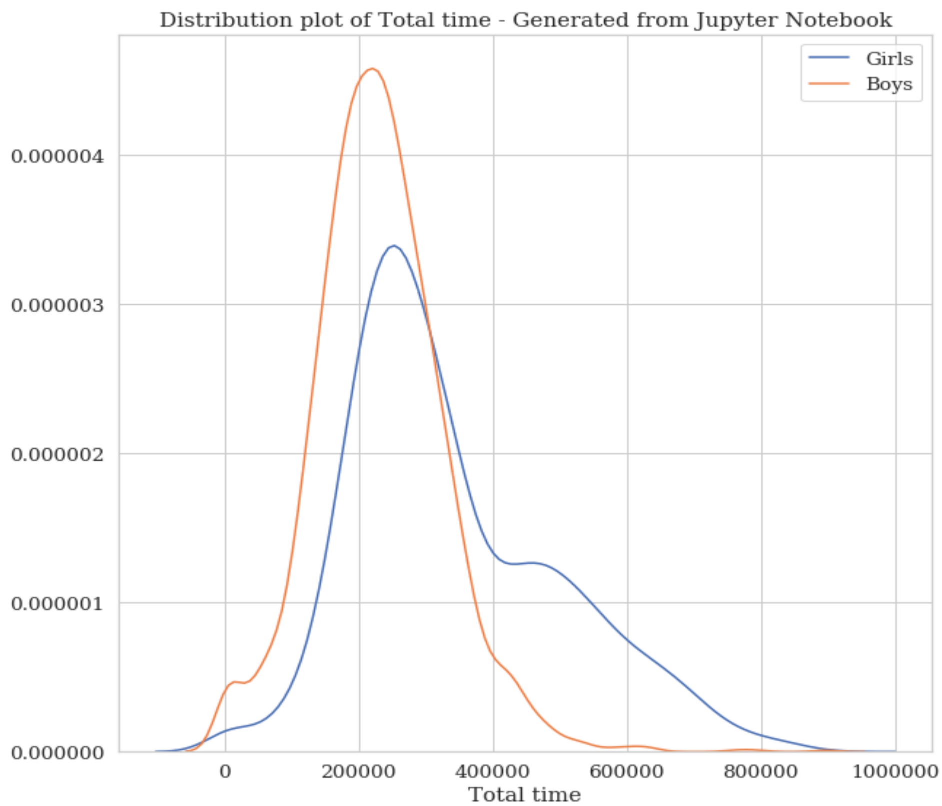
4.3.3.3 Total time spent

The below statistics show the Mann-Whitney U test output for the hypothesis test to compare the distribution of girls vs boys on the average of total time spent.

```
Statistics = 4709935.0, p = 4.687017511065919e-160.
The CLES is 0.28214335139735547
Since p < aplha : Greater (reject H0)
```

The p-value is $4.68 \times 10^{-160,}$ which is less than 0.05; hence there is enough evidence to conclude that girls spend total time on the Alef platform than boys. The plot below also shows that the girls' line is above the boys' line for higher total times. The hypothesis test to compare the distribution of the total time spent for girls vs boys on the Alef data resulted in the fact that it is statistically significant that girls spend total time on the Alef platform when compared to boys.

Figure 4. 18 Distribution Plot for Total Time Spent for Girls vs Boys



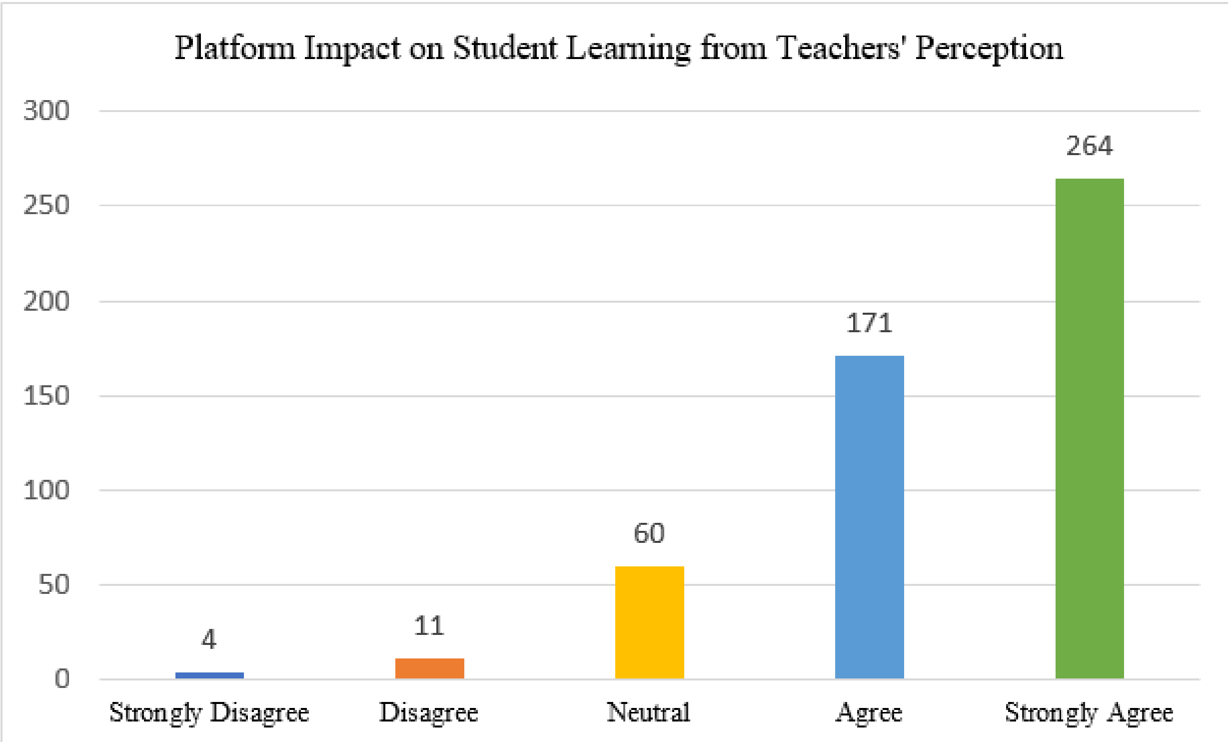
4.1.4.2 Students' performance from the Teachers' perceptions

This section presents the results of the third section in the teachers' survey, which presents teachers' perception of the impact of the Alef Platform on students' performance. This section has 6 questions starting with to what extent do you agree that the Alef Platform improves learning and teaching, supports students according to their need, increases students' motivation to learn, improves students learning outcomes, helps students discover new content and build new skills, and helps to enhance students discipline and behaviour problems. Table 4.13 below, which was generated using the SPSS program, shows that Sig. (2-tailed) is .000 for all items, which indicates that the results are very significant for all these items. The mean is above 4 for all the items, which means that all participants even agreed or highly agreed on the presented items.

Table 4. 13 One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
improves learning and teaching? – تساهم في تحسين التعلم والتعليم؟	118.325	510	.000	4.33072	4.2588	4.4026
supports your students according to their needs?تقدم الدعم للطلبة بناءً على حاجاتهم؟	97.618	510	.000	4.07828	3.9962	4.1604
increases students' motivation to learn? – تنمي حافز الطلبة للتعلم؟	111.449	508	.000	4.15914	4.0858	4.2325
improves students' learning outcomes? – تحسن مخرجات التعلم لدى الطلبة؟	110.273	509	.000	4.19216	4.1175	4.2668
helps students to discover new content and practice new skills? – تساعد الطالب على اكتشاف محتوى تعليمي جديد واكتساب مهارات جديدة؟	115.530	510	.000	4.26027	4.1878	4.3327
helps enhance students' discipline and behavior problems? – تساعد في تحسين انضباط وسلوك الطلبة؟	92.484	510	.000	4.02153	3.9361	4.1070

Chart 4. 9 Platform Impact on Student Learning from Teachers' Perception



The Chart above 4.9 presents the teachers' perception regarding how the Alef Platform improves student learning. As shown in the chart, more than 85% of the participants agreed or highly agreed that the Alef Platform improves students' learning. In comparison, 12% of the participants were neutral, and only 3% of the participants disagreed or strongly disagreed that the platform has an impact on student learning.

Chart 4. 10 Platform Impact on Student Engagement from Teachers' Perception

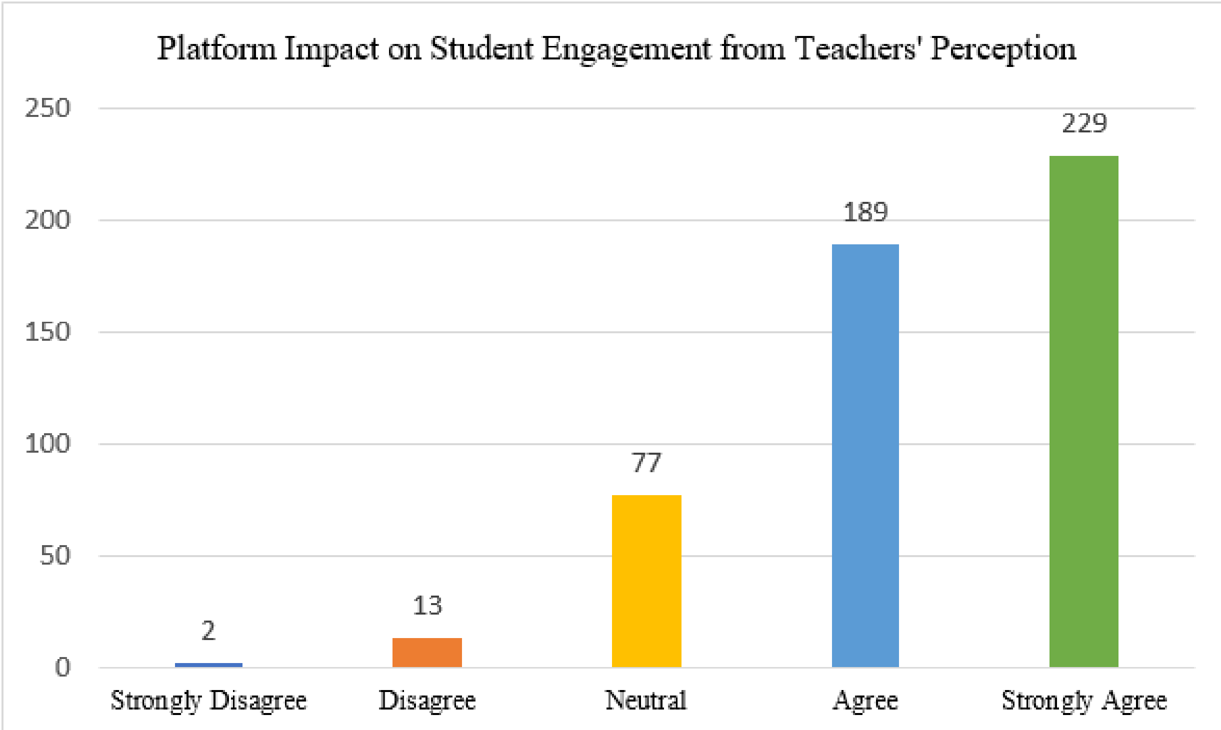
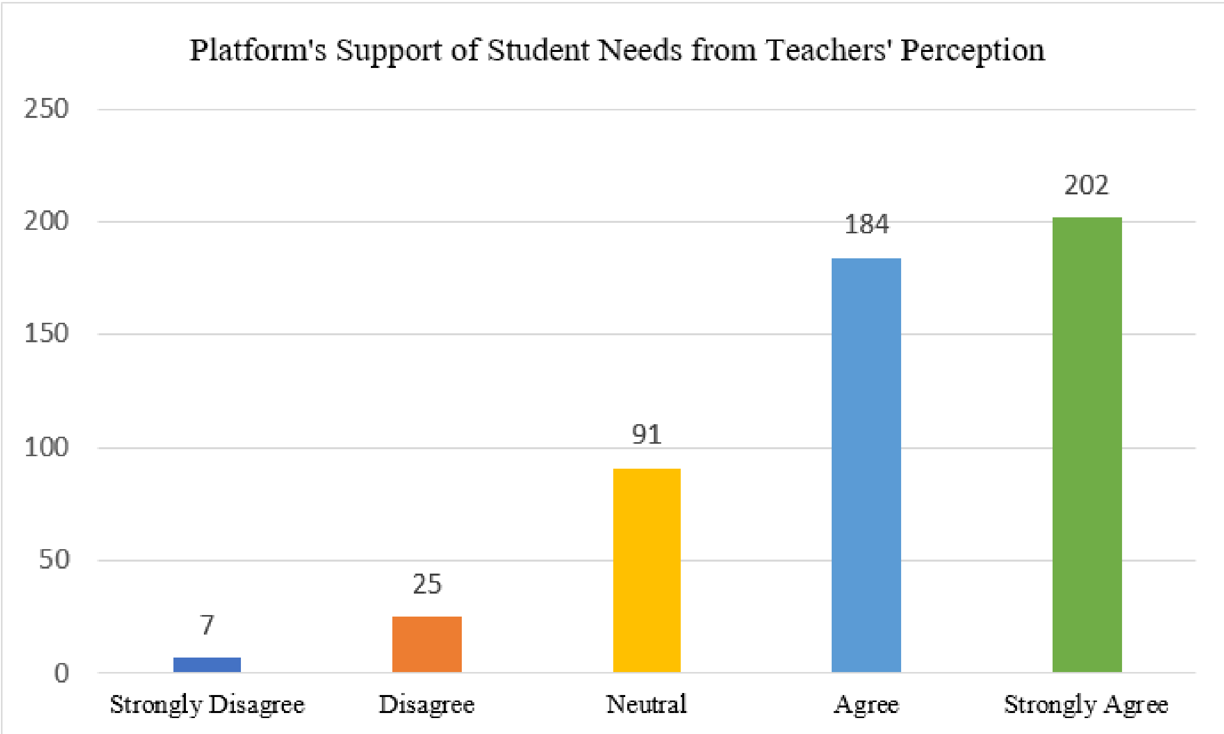


Chart 4.10 above presents the teachers' perception regarding how the Alef Platform improves student engagement. As shown in the chart, more than 82% of the participants agreed or highly agreed that the Alef Platform improves students' engagement, while 15% of the participants were neutral and only 3% of the participants disagreed or strongly disagreed that the platform has an impact on student engagement.

Chart 4. 11 Platform's Support of Student Needs from Teachers' Perception



The Chart (4.11) above presents the teachers’ perception regarding how the Alef Platform supports students’ needs. As shown in the chart, more than 75% of the participants agreed or highly agreed that the Alef Platform supports students' needs. In comparison, 18% of the participants were neutral, and only 7% of the participants disagreed or strongly disagreed that the platform supports students’ needs.

Chart 4. 12 Platform Impact on Student Motivation from Teachers' Perspective

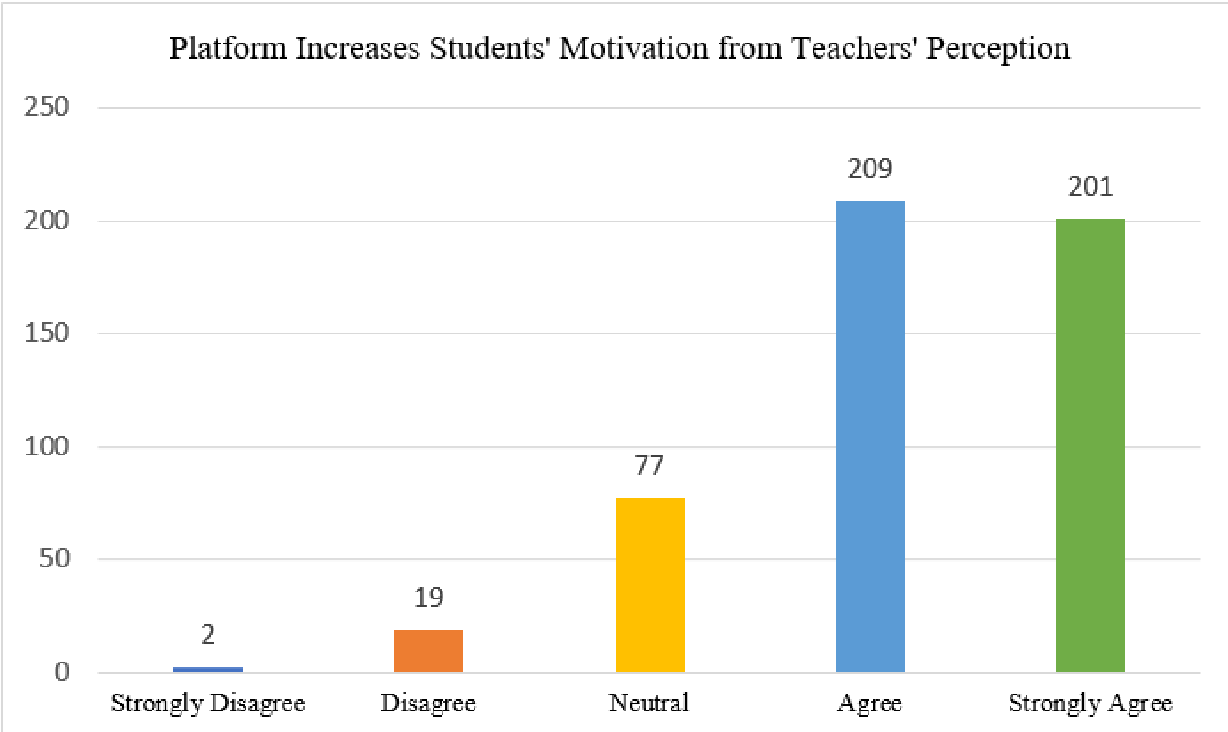


Chart 4.12 above presents the teachers' perception regarding how the Alef Platform's impact on students' motivation. As shown in the chart, more than 80% of the participants agreed or highly agreed that the Alef Platform increases students' motivation. In comparison, 15% of the participants were neutral and less than 5% of the participants disagreed or strongly disagreed that the platform increases students' motivation.

Chart 4. 13 Platform Improves Students' Learning Outcomes from Teachers' Perception

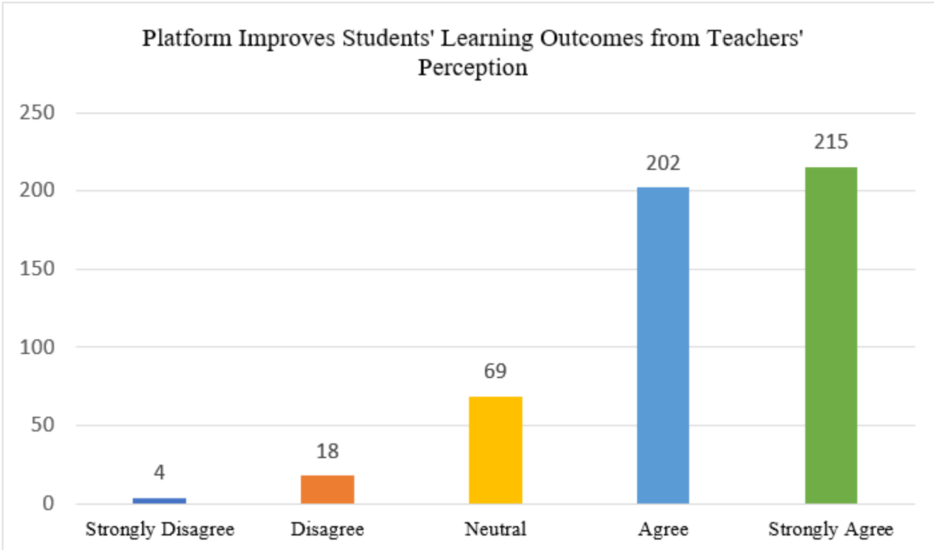


Chart 4.13 above presents the teachers' perception regarding how the Alef Platform improves students' learning outcomes. As shown in the chart, more than 82% of the participants agreed or highly agreed that the Alef Platform improves students' learning outcomes. In comparison, less than 13% of the participants were neutral and less than 5% of the participants disagreed or strongly disagreed that the platform improves students' learning outcomes.

Chart 4. 14 Platform Helps Students Discover New Content from Teachers' Perception

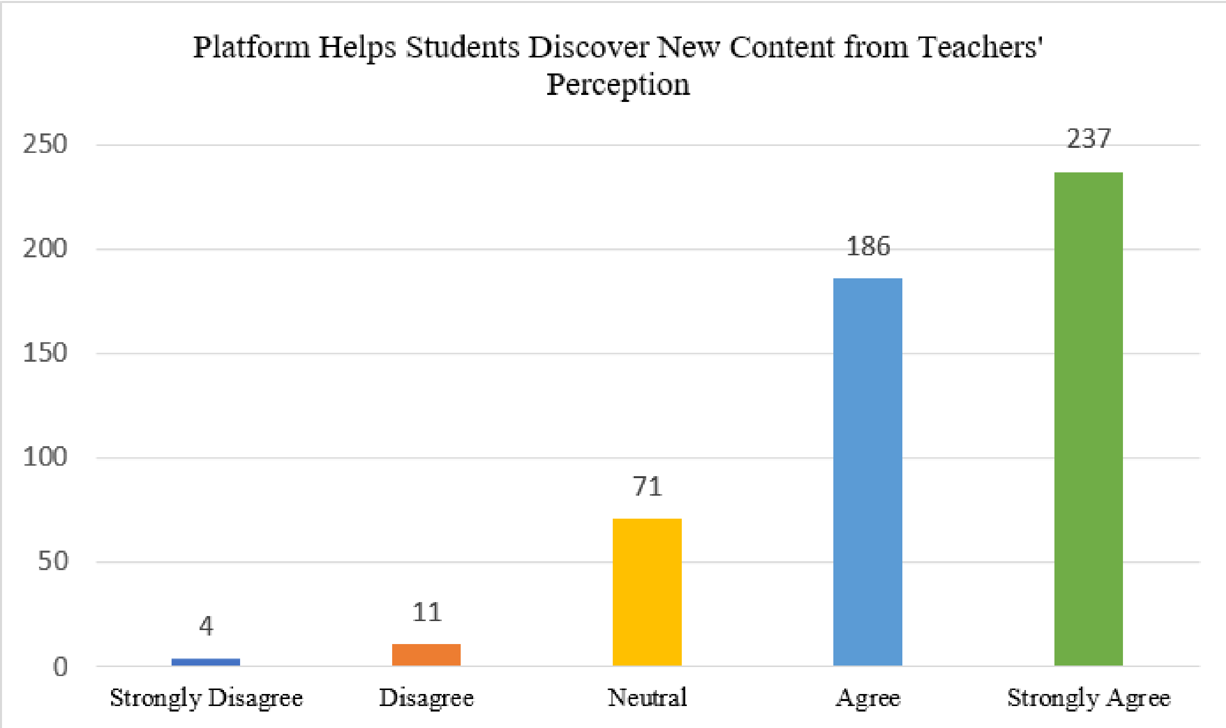
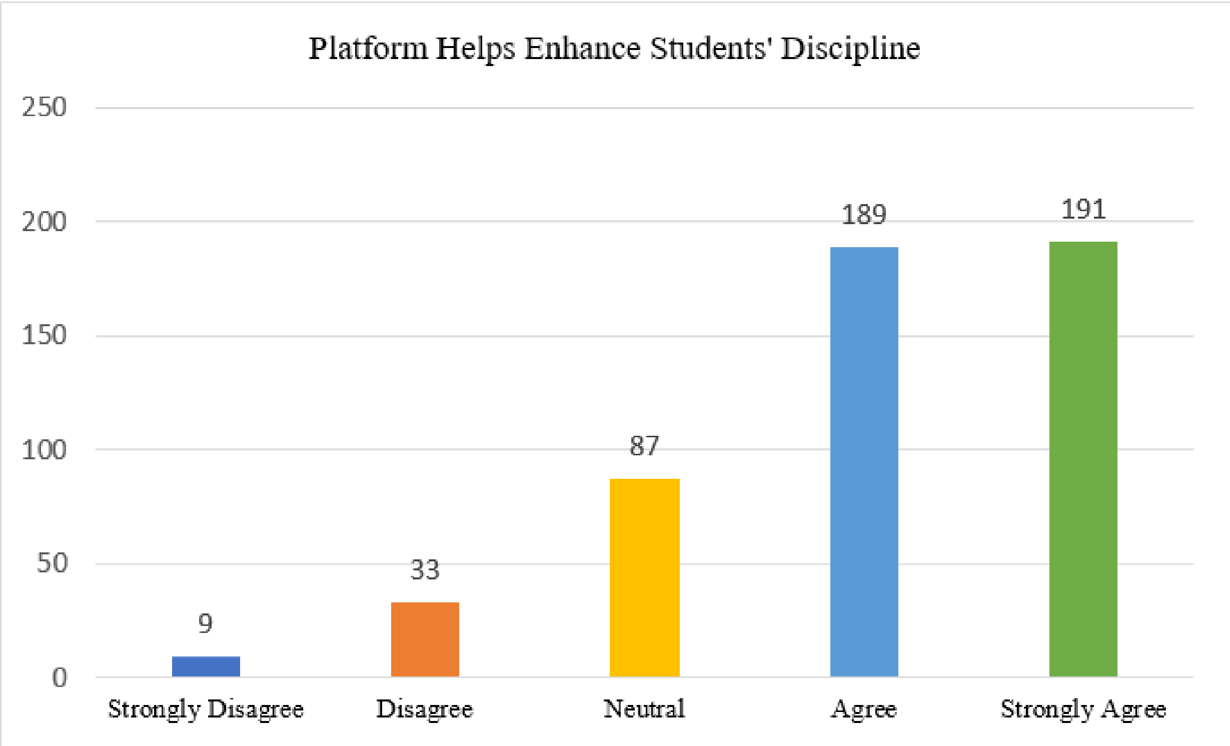


Chart 4.14 above presents the teachers' perception regarding how the Alef Platform helps students discover new content. As shown in the chart, more than 80% of the participants agreed or highly agreed that the Alef Platform helps students discover new content, while less than 15% of the participants were neutral and only 3% of the participants disagreed or strongly disagreed that the platform helps students.

Chart 4. 15 Platform Helps Enhance Students' Discipline from Teachers' Perceptions



The Chart (4.15) above presents the teachers' perception regarding how the Alef Platform enhances students' discipline. As shown in the chart, more than 75% of the participants agreed or highly agreed that the Alef Platform enhances students' discipline, while less than 17% of the participants were neutral and only 8% of the participants disagreed or strongly disagreed that the platform supports in enhancing students' discipline.

4.1.5 Teachers' Data Analysis

This section focuses on AI in digital learning and its impact on teacher practice. Two instruments were used to collect data in this aspect: teacher usage data on the Alef Platform and the teachers' survey. In this section, the researcher presents the analytical data for both instruments.

4.1.5.1 Analysis of the Teacher's activity on Alef Platform

The researcher conducted the Mann-Whitney U test to compare the teachers' usage of the Alef Platform on two groups of independent schools: the first group includes the schools that started implementing the Alef Platform in 2018 (Group 2018), and the second group is the schools that started implementing the Alef Platform in 2019 (Group 2019). This comparison enabled the researcher to get some understanding of the teachers' usage of the Alef Platform. This test helps to find out if there is a difference in the usage of the Alef Platform between the teachers in Group 2018 and the teachers in Group 2019.

The output below shows the Mann-Whitney U test for the average teacher time spent on the Alef Platform in 2018 and 2019 Alef schools for the 2019/2020 academic year.

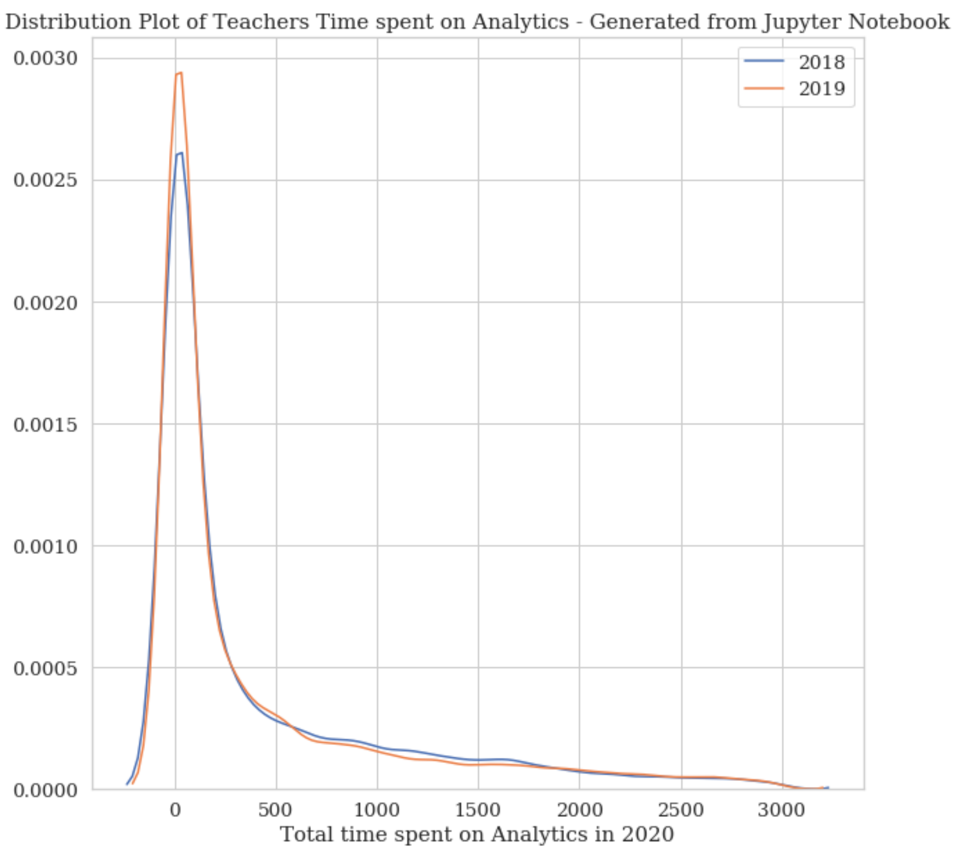
```
Statistics = 43526330.0, p = 0.0011565428950648783.
The CLES is 0.48705436668676355
Since p < aplha : Greater (reject H0)
```

The hypothesis test suggests that there is enough evidence over a 95% confidence interval to claim that teachers from 2018 schools spend more time in "Analytics" compared to teachers from 2019 schools.

The CLES is the common language effect size, and it looks at the total number of ordered pairs possible for the teacher time spent between the two groups of 2018 and 2019 schools. The CLES in the output above is 0.49; this means that for 49% of the total number of ordered pairs possible, the teachers from Group 2018 recorded greater time spent on the platform than the teachers from Group 2019.

Figure 4.19 below shows the time spent by teachers divided into two groups, the blue colour presents teachers in Group 2018, and the orange colour presents teachers in Group 2019. The graph shows that the majority of teachers spend similar times on Analytics in both 2018 and 2019. However, as Figure 5.16 shows, while time increases, the blue goes above the orange line. This shows why the hypothesis test is resulting in 2018 teachers spending more time on Analytics than 2019 teachers.

Figure 4. 19 Distribution Plot of teachers' average time spent on the Alef Platform



4.1.5.2 Analysis of Teacher’s Perceptions towards Alef Platform

This section presents the results of the second, fourth and fifth sections in the teachers’ survey, which shows the teachers' perspective toward their role and how it is impacted by the Alef Platform.

In the first section of the survey, teachers are asked to rate their skills using technology and how often they faced challenges using Technology. The majority of the participants, 85%, rated their skills using technology high or very high, as shown in Chart 5.5. Also, when asked to rate the challenges that they faced using technology, more than 75% of the respondents rated their experience as neutral, low or very low, as shown in Chart 5.5. This section also asked teachers to rate the professional development provided by the Alef team, whether face to face or digital, in terms of efficacy and quality. As Chart 5.6 shows, 90% of the participants rate the professional development provided by the Alef team are rated high or very high.

When asked about the skill ability in employing technology in the classroom, the responses ranged from normal to very high skill ability, where 71 teachers responded to have a normal skill level in employing technology, 273 teachers said their skill level is high while 165 claimed theirs to be very high, Chart (4.16).

Chart 4. 16 Teachers' Skills in Using Technology

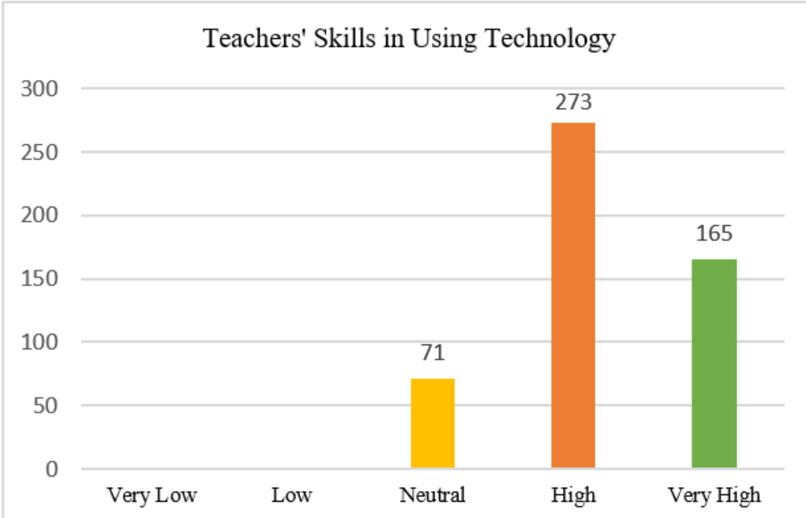
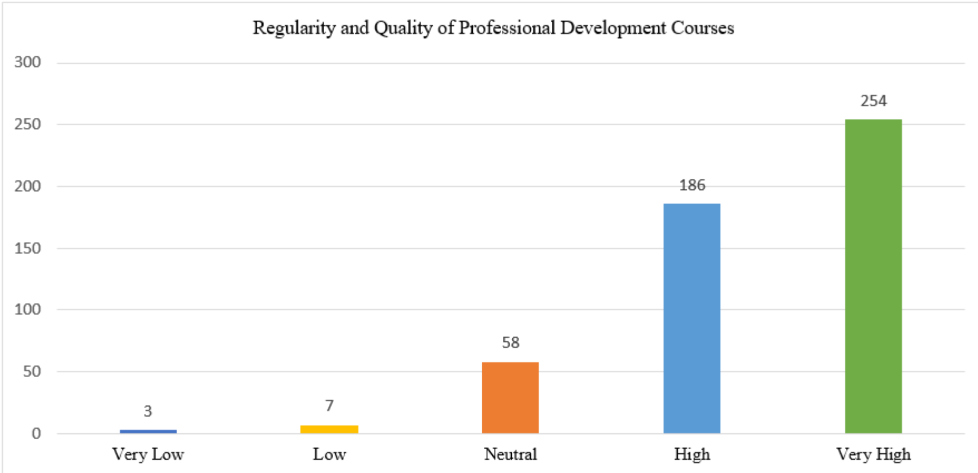


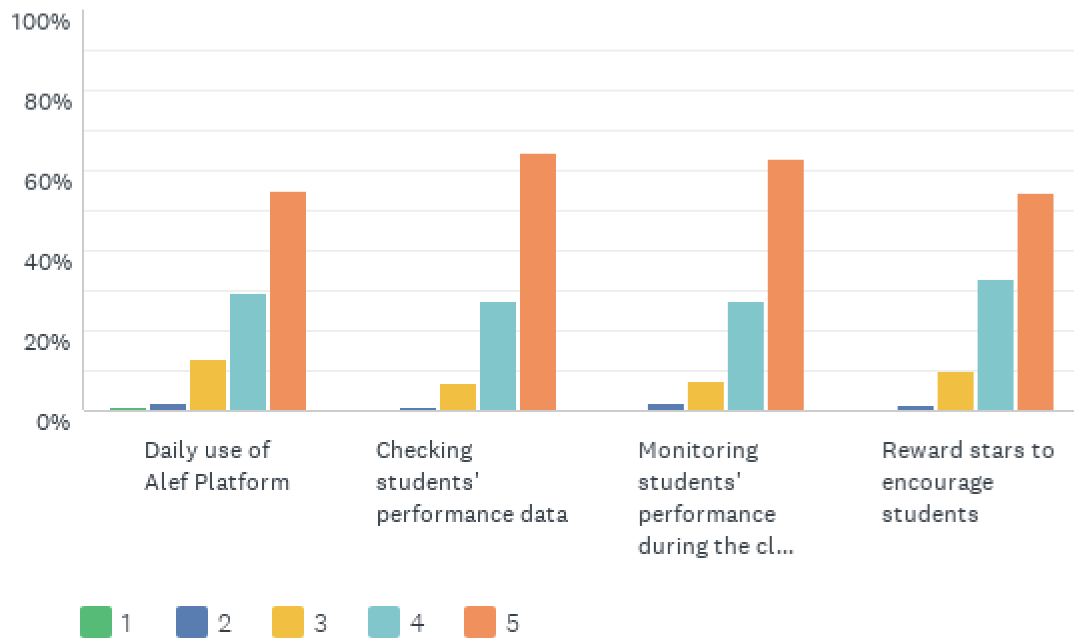
Chart (4.17) below shows the teachers' responses when asked to rate the regularity and quality of the professional development courses on how to implement blended learning using the platform. The response included 254 teachers who rated the regularity and quality as very high, and 186 teachers rated them as high, while 58, 7, and 3 teachers rated the regularity and quality of the professional development courses as normal, low and very low, respectively. This shows that more than 85% of the participants thought that they received sufficient and high-quality professional development on how to best apply the blended learning model using the platform.

Chart 4. 17 Regularity and Quality of Professional Development Courses



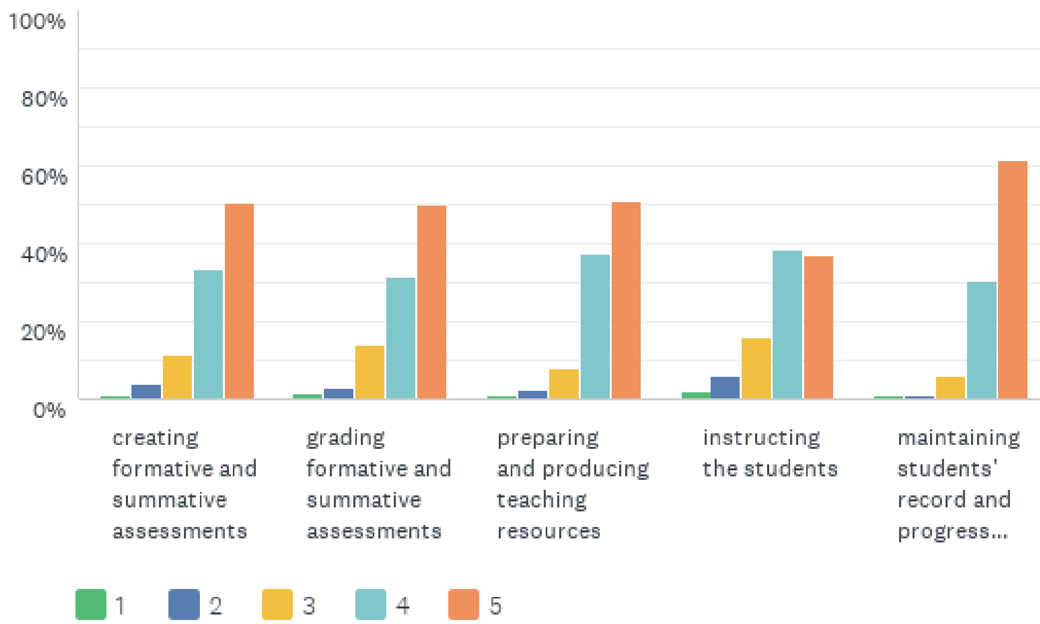
The second section in the teachers' survey asked teachers to rate the consistency of using the Alef Platform in teaching. Chart 5.18 below shows that more than 85% used the Alef Platform on a daily basis, more than 90% of the respondents used the Alef Platform to check students' performance data and monitor students' performance during classroom time; more than 85% of the respondents used the Alef Platform Reward to encourage their students to learn.

Chart 4. 18 Teachers' Usage of the Alef Platform



The fourth part in the teachers' survey shows how using AI-Powered platforms saves teachers time and effort and decreases the workload on the teachers. There are many areas where the Alef Platform saves teachers' time and workload; these areas are presented in Chart 4.19 below with the analysis of the responses received in each area. As shown in Chart 4.19, the first area is creating a formative and summative assessment and grading it automatically, and to that, more than 85% of the participants agreed or highly agreed that the ready and automated grading formative and summative assessment provided on the Alef Platform saves teachers' time and decreases their workload. Also, almost 90% of the participants even agreed or highly agreed that the ready teaching resources and materials provided on the Alef Platform save teachers' time and effort from creating or researching for teaching materials. During classroom time, the Alef Platform pulls teachers away from instructing the student and saves their time and effort to be dedicated to the students that need their support; more than 75% of the participants agreed or highly agreed that the Alef Platform saves teachers' time and effort in instructing the students. When it comes to maintaining students' records and progress reports, more than 90% of the participants even agreed or highly agreed that the Alef Platform saves their time by maintaining their students' report.

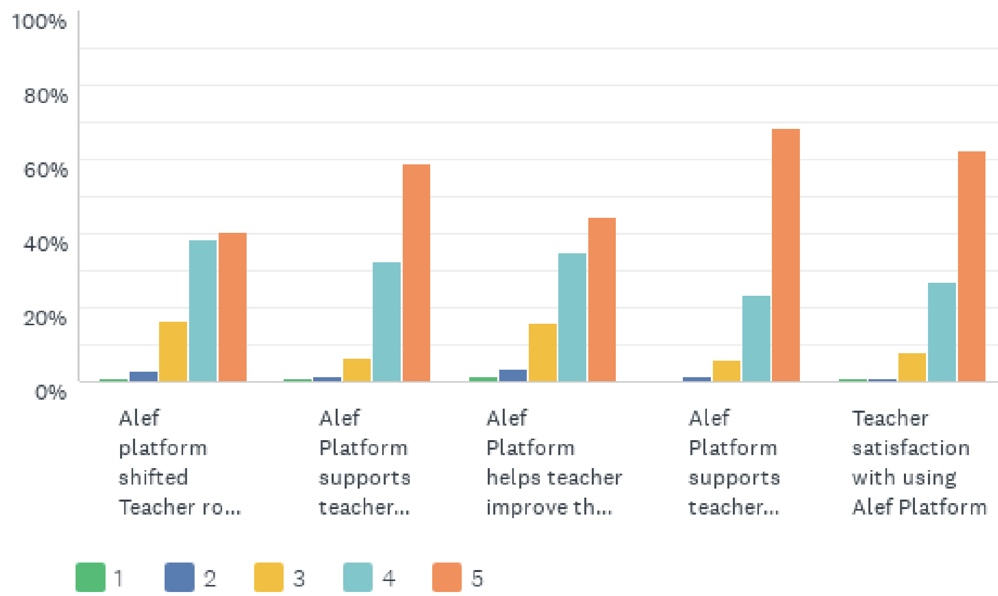
Chart 4. 19 Saving Teachers' Time and Effort



The last sections of the closed-ended survey questions help to understand the role of AI-powered platforms in transferring teachers' roles and practices. Chart 4.20 below shows that more than 75% of the respondents agreed or highly agreed that the Alef Platform shifts the teacher role from an instructor into a facilitator or coach. Almost 90% of the participants agreed and highly agreed that the Alef Platform supports teachers by tracking each student's progress during their learning journey and coaching them throughout the process. Almost 78% of the participants agreed and highly agreed that the Alef Platform helps teachers improve their classroom management. More than 90% of the participants agreed and highly agreed that the Alef Platform supports teachers during remote learning amidst COVID-19. When it comes to the teachers' satisfaction using the

Alef Platform, more than 90% of the participants agreed and highly agreed that they are happy with using the Alef Platform.

Chart 4. 20 Transferring Teachers' Role and Practices



4.1.6 Data Analysis during COVID-19

This section provides the analytical data on how AI digital learning has impacted the education sector during the Coronavirus/COVID-19 pandemic. This analysis provides some evidence about how AI-powered digital learning platforms helped the education sector, especially students and teachers, during the Coronavirus (COVID-19) pandemic. There are two instruments that were used to collect data in this aspect: students' data on the Alef Platform and teachers' survey.

The researcher conducted the Mann-Whitney U test to compare students' usage of the Alef Platform to understand if there is a difference in the time spent and the number of lessons completed by students on Alef before and during COVID-19.

4.1.6.1 The average student time spent per stage

The output below shows the Mann-Whitney U test for the average time spent per student on the Alef Platform before and during the COVID-19 pandemic for the 2019/2020 academic year.

```
Statistics = 14521322.0, p = 4.2955435690928144e-45.
The CLES is 0.41891470912706247
Since p < aplha : Greater (reject H0)
```

There is enough evidence of over a 95% confidence interval to state that the average time spent per student is greater during the pandemic versus before the pandemic.

4.1.6.2 The number of completed lessons

The output below shows the Mann-Whitney U test for the number of completed lessons per student on the Alef Platform before and during the COVID-19 Pandemic for the 2019/2020 academic year.

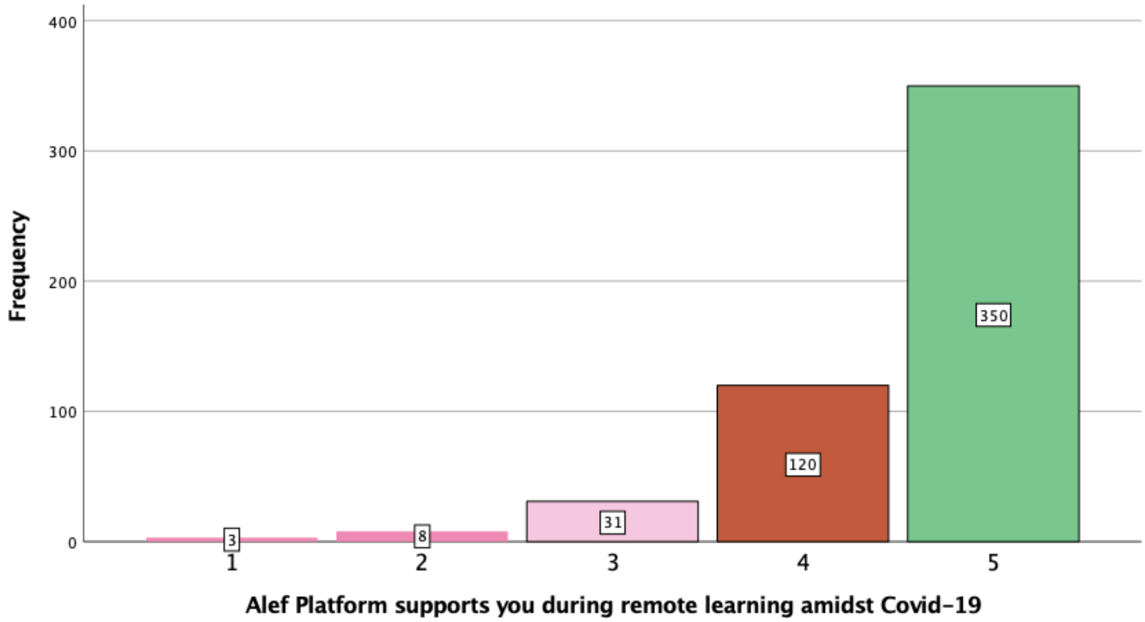
```
Statistics = 21452444.5, p = 0.0.
The CLES is 0.1415588778888004
Since p < aplha : Greater (reject H0)
```

The above analysis shows enough evidence of over a 95% confidence interval to state that the number of completed lessons per student during the pandemic is greater than before the pandemic.

4.1.6.3 Teachers' perceptions towards the impact of Alef Platform during COVID-19

The teachers' survey asks the teachers if they believe that the Alef Platform supports them during remote learning amidst COVID-19. In Chart 4.21 generated using SPSS, 350 participants highly agreed, and 120 agreed that the Alef Platform supports them during the COVID-19 pandemic. This means that 91% of the participants believe that the AI-powered digital Platform provides them with the needed support during the implementation of distance learning.

Chart 4. 21 Alef Platform's Support During COVID-19



4.2 Qualitative Data Analysis

This section presents the analysis collected from the open-ended questions included in the survey that was sent to teachers and schools' administration staff using the tool SurveyMonkey. This data was coded according to its themes that align with the questions of the thesis via the SPSS Program and the wordcloud feature included in the SurveyMonkey tool. The purpose of the open-ended questions was to understand the teachers' perspective towards the AI-powered platform and its impact on students and teachers and link the analysis of the collected data to the thesis questions. The open-ended questions were sent to 600 teachers, and the number of responses received was 512, which adds considerable value to the thesis. Therefore, the results of those open-ended questions contribute to the study and consolidate its results as the feedback was received from teachers who are working on a daily basis on this AI-enabled platform along with their students who are also using this AI-platform for their daily learning. In addition, the questionnaire aims to understand the challenges that teachers face regarding the implementation of the platform. The open-ended questions are as follows:

- Did you face any challenges while using the Alef Platform? If yes, what are these challenges?
- How is Alef Platform supporting you during Covid-19?
- Please provide any other feedback or comments you would like to share related to your experience using the Alef Platform.

Out of the total number of responses received (512), 14 responses were not considered valid. Each participation shares one or more feedback. These open-ended questions were analyzed by coding on the SPSS program and using the word clouds feature in SurveyMonkey to highlight the most recurring words amongst all the responses. Picture (4.20), which is generated by SurveyMonkey, shows the associated word cloud. Word cloud shows how many times a particular word has been repeated. For example, the words “learning” and “students” are displayed in Figure 6.1 as the largest words, indicating that they are the words most used, and upon clicking on these words, all the sentences that included them are shown in a list. This lists the responses that included the words organized from highest (most repeated words) to lowest (least repeated words).

Figure 4. 20 Example of the Word Cloud

This analysis shows the impact of AI-Powered platforms on students' learning and engagement, teachers' role and how this platform supports teachers and students in remote learning during the COVID-19 situation. Therefore, the researcher divides the teachers' participation under five main themes; namely, teachers' perceptions towards Alef Platform in relation to student learning; teachers' perceptions towards Alef Platform's contribution to student engagement, how Alef Platform enhances class, time, and workload management for the teacher, how Alef Platform supports teachers during COVID-19 situation, teachers' challenges in implementing blended learning using the Alef Platform and the teachers' recommendation. The researcher analyzed the teachers' participations generated from the list view option in the word cloud feature by categorizing these participations under the relevant theme.

The participants that share a common topic are presented under the related section as shown below.

The majority of the respondents shared very positive feedback; the most used terms were: excellent, good, perfect, helps, great; these words were used more than a hundred times. The teachers used various terms to present their perspective in general, as verified by the following examples of participation:

T8: *"It is the best platform for teachers and students."*

T2: *"Alef makes the teaching and learning process effective and easy. Thank you, Alef."*

T40: *"Thanks, Alef, for making studying fun for our students."*

T21: *"Excellent platform. The upgrades made are great."*

T5: *"It has been a very useful platform, especially in terms of differentiated questions".*

T12: *"Everything is clear and easy to reach all information whenever they need it."*

T32: *"It is a one-stop destination for everything."*

T51: *"It is sufficient material for lessons."*

T16: *"It is an excellent platform both for students and teachers as it is tailor-made in terms of teaching and learning. A perfect blend of Excellence."*

4.2.1 Teachers' Perceptions toward Alef Platform in relation to Student learning

This section presents qualitative participation that relates to quantitative data analysis, which indicates that there is a strong positive relationship between implementing AI-Platform and students' learning. Teachers believe in the Alef platform, and they unanimously agree that it enhances students' learning. They also like the platform for its content as it is aligned with the MOE curriculum, as mentioned in the following participation:

T18: *"Well-prepared lessons go hand in hand with the MOE curriculum. Student's practice of the lessons. Assessment."*

Another teacher indicated that the platform enhances students' knowledge, as mentioned in the following participation:

T45: *"Alef is very good at enhancing the knowledge of good scorers."*

The participation also talked about the fact that the platform supports student learning at their own pace, as was suggested in the following participation examples:

T1: *"Students can study and learn at their own speed."*

T19: "*Excellent for allowing students to work at their own pace and with great resources."*
Another feedback pointed out that the platform develops independent learning in students as it was mentioned by the following participation that the platform is

T3: *"Creative, different skills practised, great for fast and independent learners, fosters self-study skills and curiosity, problem-solving skills."*.

Another teacher talked about how the immediate feedback in the platform helps students, saying that:

T25: *"Alef Platform is user-friendly and provides instant feedback to enable students to learn and correct their mistakes."*

Another participant indicated that the platform is important for raising students' interaction in the classroom, as it was mentioned by the following participation that:

T17: *"Alef platform becomes a necessity in our schools as it facilitates learning in such an interactive way."*

The responses pointed out that the platform improves students' critical thinking skills, amongst others, as mentioned by the following participants:

T36: "*Very helpful enhances students' interaction, critical thinking skills."*

T7: *"Alef platform provides the content and its visuals in an organized way which enhances the learning. As well as helps the learner to practice new skills."*

Another teacher also affirmed that the platform serves to enhance the students' learning experience, as mentioned in the following participation:

T14: *"It is amazing. It has helped me to enhance my students' learning experience to meet the outcomes."*

The participants also mentioned that the lessons on the platform are informative and well-organized, as the following participation stated that the platform has:

T43: *"Interactive and informative lessons that students love."* and that *"Students can view lessons by themselves and be more independent."*

Other teachers touched upon the learning objectives that the platform helps to achieve, saying that the platform works as a primary tool and helps to achieve learning outcomes as mentioned in the following participation:

T38: *"As a primary tool for much better understanding of the learning objectives."*

T6: *"Achieve learning outcomes and maintain discipline."*

Another teacher mentioned that the platform supports raising awareness, saying that:

T47: *"It was very helpful to raise awareness among students."*

Another teacher indicated that the platform helps guide the teacher where to help students as it was mentioned that the platform:

T27: *"Support my students according to their needs."*

Another teacher pointed out how the platform supports students, as it was commented that:

T56: *"It supported students with an interesting way to learn."*

Another teacher also mentioned that the platform's approach enhances student learning, saying that the platform takes a:

T15: *"Uniformed approach to learning, students are used to the drill and build new skills."* Furthermore, another teacher talked about the digital tutoring the platform provides, as the following participants stated:

T33: "*It provides Online tutoring with amazing videos and Brainstorming questions for students."*

T13: *"Alef has become an excellent digital platform for the students as there* is student self-*paced."*

4.2.2 Teachers' Perceptions toward Alef Platform's contribution to student engagement

This section presents the participation related to the students' engagement with learning materials. Some participants indicated that the Alef Platform provides interactive content that supports students' engagements with the learning materials. Some of the participants talked about the Alef Platform, saying that:

T78: "*It provides engaging content for students to interact with.*"

T71: *"Engaging the learning process to motivate and instill desire to learn."*

T51*: "It strongly helps student engagement and monitors their progress."*

T38: *"It is interactive and keeps students on task."*

T13: *"It is engaging and fun and has all tools for education."*

T65: *"To motivate the students towards learning."*

T22: *"Alef supports me by providing such a motivating interactive learning program that helps students enjoy studying."*

T53: *"It is one of the best platforms used for student engagement and differentiation."*

4.2.3 How Alef Platform enhances class, time and workload management for the teacher

This section analyzes the open-ended participation from the teachers' surveys that are related to the teachers' practice and role. The results from the quantitative research suggest that the AI-powered platform saves teachers' time and decreases their workload by providing them with teaching resources and material as well as ready and automated formative and summative assessments. Participation in the open-ended questions supports the quantitative results. There were comments from the teachers about the platform as follows:

T23: *"Reduces effort on the teacher when it comes to preparing activities."*

T47: *“Saves me the time of planning and grading.”*

T61: *“It reduces time in planning as the questions in assessments is evaluating the students in a formative way.”*

T18: *“Provides materials for teachers and students, saves time and effort.”*

T55: *“Save time in forming some practice activities for students.”*

T38: *“I am pleased that I do not have to do as many activities.”*

Another result from the quantitative analysis that is related to the teachers’ practice is that the AI-Powered platform helps teachers to better manage the classroom and track students’ progress. Many participants in the open-ended questions support this finding as follows:

T46: *“I can control my students over distance and make sure that they are learning and following me during the lesson as it is required from them to finish the Alef lesson. It also helps me track students’ progress to provide them with the needed feedback based on their needs.”*

T22: *“What I really liked most this year is when the teacher can lock parts of the lesson. Just to make sure that students are reading and understanding before they move to the next part.”*

T4: *“prepared content and assessments allowed me to give lessons easier and monitor students’ progress.”*

T10: *“Monitoring student progress and providing a variety of materials.”*

T51: *“It helps me in following the students' performance very easily.”*

T43: *“Gives me a good idea about a students’ participation.”*

T52: *“Very helpful to check their progress.”*

T36: *“Helps me to monitor their understanding and to progress.”*

T13: *“Saves so much time! Help to keep track of progress and observing student participation.”*

T5: *“Using Alef student progress helps me to check the student's understanding.”*

T65: *“Easy way to collect assignments.”*

T26: *“Alef data analysis helps to evaluate the students”.*

Lastly, the other conclusion reached from the quantitative analysis results was that the AI-Powered platform helps teachers to transform from giving traditional teaching and learning to be more as a coach or facilitator. The participation in the open-ended question shows further support of this conclusion, as shown below:

T56: *“It helps in teaching the lesson effectively.”*

T60: *“Alef games help me a lot as a plenary.”*

T26: *“It's helping plan my lessons more systematically.”*

T15: *“It is a good platform which helps the teacher in delivering the required topic in a proper way.”*

T49: *“Effective platforms with various features help enhance teaching.”*

T17: *“Helps with the content and planning digital lessons. Is available for asynchronous learning.”*

T57: *“The inbuilt lesson helps to deliver content with ease.”*

Moreover, some participants indicated the importance of the ongoing training and professional development courses, whether conducted digital or face to face; these responses are as follows:

T63: *"As teachers we get support from Alef from the digital courses in Alef academy in addition with the training sessions we get from our assigned Alef trainer! Alef helps us by saving us time from collecting teaching material and as teachers we focus more on checking our students' data and preparing action plans accordingly! Alef also gives us the option to add our own content (assignments, games) in order to provide extension to strong students and support to the weak students."*

T34: *"The Alef team provides us with a variety of remote training."*

4.2.4 How Alef Platform supports teachers during the COVID-19 situation

This section presents the analysis of the qualitative data that was collected from the teachers' participation in the open-ended part of the survey, supporting the results of the quantitative data that indicated that the Alef Platform plays a vital role in the continuation of learning during the COVID-19 situation. The teachers' views in relation to the Alef Platform's role during COVID-19 were as follows:

T63: *"Alef has been an incredible help! It allows me to monitor my students through each lesson. This is wonderful as we are teaching digital through the COVID-19 situation. Despite the distance, learning Alef has allowed me to manage student participation, lesson completion, attendance, and progress. It has been such an amazing help to navigate the classes digital in an orderly and sequential way. I love it."*

T45: *"It helps me during digital teaching because it gives a material that is ready to be used. I don't have to prepare and make the questions by myself."*

T68: *"Alef makes distance learning so much easier. Thank you for all the effort and support."*

T43: *"It is wonderful that all the students actively participate in digital classes, as their live data."*

T55: *"I can control my students over distance and make sure that they are learning and following me during the lesson as it is required from them to finish the Alef lesson. It also helps me track students' progress to provide them with the needed feedback based on their needs."*

T37: *"helped the students to continue learning from home."*

T51: *"It allows teaching and learning to continue fluidly."*

T71: *"It's very supportive of digital teaching."*

T59: *"I used the platform to sign the students with lessons while they were away."*

T41*: "With the help of Alef platform, students never missed a class in the core subjects."*

T31: *"Very good support during distance learning lessons."*

T78: *"In COVID-19 Alef is very useful. Very easy to reach the targets."*

T20: "*Online teaching and easy tracking of who is doing the work."*

T53: *"Helps implement hybrid learning."*

T42: *"This is the best tool for distance learning."*

T38: *"I like the lessons which they can do at their own pace in distance learning."*

T62: "Lots of activities on the Alef platform make the lesson very interesting due to this digital schooling."

T73: *"I can easily check the student progress after each objective."*

T53: *"Excellent digital facility for students to work independently and within the classroom."*

T11: *"It helps a lot in implementing lessons in remote learning."*

T70: *"It gives students the opportunity to work from home."*

T53: *"Alef provides a very good education for students so that the learning process is not disturbed during this COVID-19 crisis."*

T54: *"It helps in a great way to engage the students during these remote learning classes."*

T32*: "Alef Education is prepared to ensure that learning does not stop during COVID-19."*

4.2.5 Teachers' challenges in implementing blended learning using Alef Platform

More than 300 respondents mentioned that they don't have any challenges. The other respondents shared the challenges they have faced, and those challenges can be organized into two main groups. The first group asked what the number of lessons that the teachers need to cover is based on the MOE curriculum. The second group of feedback included the recurring term "access level", which means the third level as per the MOE's categorization of students' performance level, namely, the advanced level, which includes the high-performing students, the general level that covers the regular performing students and the access level that includes students that show weak performance. This group of teachers mentioned that they face challenges with the access level students because the English language skills that those students have are low, and they cannot read and understand the material available on the Alef Platform.

The feedback that is related to the number of lessons was as follows:

T31: *"Too many lessons. Long lessons were broken up into micro-lessons that still took up the entire lesson, so left little or no time for other platforms or resources."*

Another comment was that:

T61: *"There are already so many learning outcomes in math, reducing the number of lessons on the Alef platform, instead of breaking them up into parts."*.

One of them mentioned the options of questions given to low-performance students, as it was written that:

T44: "*Students have got so many options for one question, those students who are very weak in studies they can't even read those options and are unable to think of the right options. I would like to request please make it to 3 options that are enough for the low achievers."*

Another teacher commented on the volume of the content, saying:

T58: *"The content is massive especially for lower grades."*

As for the teachers who raised the point of the students who have weak English language skills, their feedback read as follows:

T49: *"The only challenge is with the access level. The content is written in a way that isn't easily accessible to the majority of the access level students. It, therefore, requires a lot of effort and* *preparation in trying to explain the lesson to students which contradicts the notion of having the teacher as a facilitator."*

"Some questions are above the level of students' learning outcome."

T67: *"I love the Alef platform to engage my students however it needs to be presented in an easier way for English access level students. The creators of these lessons need to consider the fact that these are students who struggle to read so posing a question with difficult vocabulary or middle/high level questioning techniques is incomprehensible to these students. In addition, most of the access students struggle with English so their attention span is limited which is why the explanations need to be short and simple. A video explaining the explore option would be far more beneficial than expecting these students to read because the majority of them choose not to."*

T14: *"Students find some of the language challenging."*

T3: *"Use of language is very high, especially gr6 science is not proper the terminology that is used in normal questions about easy work, taking in consideration it is 2nd language students that are 10 years old."*

The teachers' participation in relation to difficulties some students face, such as, lack of English language skills or other basic skills, explain the anomalies found in quantitative data analytics, which shows that the Alef Platform is very helpful for most students; however, the curriculum and content in the platform does not serve low-performing students who have some learning difficulties; therefore, it needs to be modified to better suit those students' needs.

4.2.6 Teachers' recommendations

In the end, some teachers put across their recommendations on what they would like to see added or considered on the Alef Platform. The teachers recommended that the simulation and virtual labs features, which are currently used in Science and Math, to be included in Biology; as follows: T5: *"We want to add more virtual labs in Alef because it's not more in the Biology curriculum."* T65: *"New updates are very useful. I suggest, if possible, to add simulations for some classes."* T15 recommended that the Alef Platform should *"use simple structured and short sentences and avoid difficult vocabulary to support students who struggle with the English language.* Additionally, the teacher further recommended that *"Alef Platform include concise sentences, explanations and videos to address students with short attention spans."* Many participants suggested that one of the strengths of using Alef Platform is the fact that it includes the six core subjects, so the teacher is kept aware of all the skills that their students learn across all six subjects and the progress they have achieved in each of these skills; making it possible for teachers to complement and support each other.

4.3 Conclusion

This chapter presents quantitative and qualitative data analysis that provides an answer to the thesis questions. In conclusion, the data results show that the Alef Platform, in general, has a positive impact on student learning for the majority of students; however, students who do not master the English language might struggle with the learning content due to the language barrier, as science and math subjects are taught in the English language in the public schools. The data analysis shows that there are many indicators that suggest that AI-driven digital learning improves students' learning. For example, the correlation between the average summative assessment scores and the average time spent per stage on the Alef Platform is significantly positive, which means that the longer students learn on the platform, the better their learning outcomes are. There is also a statistically significant strong positive correlation between the time spent on the Alef Platform and the students' score in the ministry final exams. This means that spending more time learning on the Alef Platform led to obtaining better results in the MOE exams. In addition to that, the students in the 2018 group of schools had higher results in both MOE exams and the diagnostic tests than students in the 2019 group of schools. This means that students who learned using the platform for two academic years achieved better results in the diagnostic tests when compared to students who learned on the platform for one academic year. The engagement analysis suggests that the students attending the 2018 group of schools spent more time on the platform and completed more lessons compared to students who attend the 2019 group of schools. The teachers' perspective supports these results, as most teachers believe that the Platform increases students' engagement with the learning materials available on it. Furthermore, qualitative data analysis proves that using AI-Powered platforms saves teachers' time and effort, decreases the workload on the teachers and helps them to transform their teaching style from being traditional teachers to being facilitators or coaches. Lastly, there is enough evidence to state that the number of completed lessons per student during the COVID-19 situation is greater than before the situation, which proves that the platform plays a vital role in the continuation of learning during the COVID-19 situation.

The results of the participation in the qualitative section express the teachers' perspective toward the Alef Platform. The teachers' opinions and beliefs are very important as teachers are the ones who deal with the platform and the students on a daily basis, and their opinions must be taken into consideration.

From the analysis of both quantitative and qualitative data, there is strong evidence to prove that AI-driven platforms improve students' learning, behaviour, motivation to learn and engage with the learning materials, which ultimately leads to improved learning outcomes. AI-driven platforms also help teachers to improve their practice, as such platforms empower the teacher by providing them with the facilities necessary for the teachers to be able to transform into facilitators or coaches and not just instructors of the students. The AI-powered platform also provides teachers with live data on the progress of their students to be able to follow their progress on a daily basis so they can make their decisions based on this data and provide immediate support to the students according to their needs. Additionally, the qualitative data results show that the AI-powered platform plays an important role in the COVID-19 situation and that it supports the education field as it was prepared for that. Therefore, such a platform is indispensable to overcome this situation by supporting the process and continuity of learning.

CHAPTER 5: DISCUSSION AND CONCLUSION

5.0 Introduction

This chapter discusses the findings of the research questions, which represent the results of the analysis of the quantitative and qualitative collected data. The discussion presented in this chapter is based on the results of each of the four thesis questions. This thesis tackled four main questions, as follows:

1) How does AI-driven digital learning improve students' learning?
2) What are the teachers' perceptions of AI-powered digital learning platforms?
3) How does the implementation of AI in digital learning impact teachers' practice?
4) How do AI-powered digital learning platforms help students and teachers during Coronavirus (COVID-19) pandemic?

The findings are presented according to each question, respectively, right after the holistic overview of the current thesis and the instrument used. This chapter concludes with the recommendations drawn from the findings of the thesis, as well as the limitations of the thesis and further direction for future research.

5.1 The overview of the study

This research involved 7039 students and 512 teachers from 12 public schools in the UAE, which gives a high value to this research. The thesis is aimed at exploring the impact of an AI-powered platform (the Alef Platform) on students' learning and engagement as well as teachers' practice; it also seeks to understand the role of this platform during the COVID-19 pandemic. To get strong and solid results, the researcher conducted a mixed-method research approach that combines qualitative and quantitative data collection methods. The qualitative data was collected from 512 teachers who use the Alef Platform in their teaching and who responded to the teachers' survey that was sent to them via SurveyMonkey tool. The survey ended with three open-ended questions that seek the teachers' perspective on the platform. The collected answers were first coded to link each response with the research questions and then analyzed using SPSS and Excel software in addition to the Word Cloud tool in SurveyMonkey.

Quantitative data is used to examine the relationship between various factors related to each research question using the 7039 students' behavioural data over one academic year. The collected data includes the average of learning time spent on the Alef Platform during the year, the number of completed lessons on the Alef Platform, and the average of each student score in the formative and summative assessments done throughout the student's learning journey over the academic year 2019/2020. This data is then compared with the students' results in MOE final exams in term one of the same academic year of 2019/2020, and with the students' results in the diagnostic tests that students had taken in three different subjects Maths, Science and English language. After the data is analyzed, the researcher links it to the results of the teachers' survey analysis. Multiple Null hypotheses were used to examine the relationships between each of the factors; another number of null hypotheses aims to explore the difference in the implementation of the Alef Platform between the six schools that started to implement the Alef Platform in 2018 and the other six schools that started to implement the platform in 2019. Each research question is addressed by a number of these hypotheses. A complete summary of all the used hypotheses and the explanation of their closure is presented in tables (5. 1, 5. 2, 5.3, 5.4) accordingly in each related section below. The Pearson correlation coefficient and the Spearman correlation coefficient scales were used to examining the relationship hypotheses, and the Mann-Whitney U test was used for all the hypotheses that were compared between the two groups of schools.

5.2 How does AI-driven digital learning improve students' learning

This section discusses the impact of the Alef Platform in improving the students' learning and performance. Direct and indirect relationships among multiple factors related to students' learning and performance were examined by analyzing the learners' journey during one academic year. All the null hypotheses used to examine the relationship between implementing the Alef Platform and students' performance is summarized in Table 5.1 below. The findings of these hypotheses are later linked to the results of the teachers' survey, including both the closed-ended and open-ended questions that explore the impact of the Alef Platform on students' behavioural and academic performance from the perspective of the teacher.

Table 5. 1 Students' Performance

1. How does AI-driven digital learning improve students' performance?			
No.	Null hypothesis	Analysis closure	Alternative hypothesis/closure
1. 1	There is no relationship between the Time Spent on the Alef Platform and Final Concept Mastery.	Rejected	There is a strong relationship between the time spent on the Alef Platform and the final concept of mastery.
1.2	There is no relationship between the final score on the Alef Platform's summative assessment and the final score in the MOE's exams.	Rejected	There is a strong relationship between the final score on the Alef Platform's summative assessment and the final score in the MOE's exams.

1.3	There is no relationship between the Time Spent on the Alef Platform and the final scores in the MOE's final exam.	Rejected	There is a strong relationship between the time spent on the Alef Platform and the final scores in the MOE's final exam.
1.4	There is no difference in MOE's test results between the 2018 group and the 2019 group of schools.	Rejected	Students in the 2018 group had better results in MOE's final exam score than students in the 2019 group of schools.
1.5	There is no difference in the diagnostic test results between the 2018 group and the 2019 group of schools.	Rejected	Students in the 2018 group had better results in diagnostic tests than students in the 2019 group of schools.

The first finding from examining the hypotheses mentioned in Table 5.1 is that there is a strong positive relationship between the time spent on the Alef Platform and the average summative assessment, which represents the final concept mastery. The more time students spend interacting with the learning materials on the Alef Platform, the higher their score in the summative assessment is. In addition, there is a strong positive correlation between the final score the students achieve on the summative assessment on the Alef Platform and the final score in the MOE exams. This might be because the content on the Alef Platform is aligned with the MOE content curriculum, which is also mentioned in the participation in the open-ended questions. The research finds also a strong positive correlation between the average final score in the MOE exam and the average time spent on the Alef Platform. This means that students who spend more time and effort completing most topics score higher in the MOE's final exams than the other students. Another important finding was reached by comparing students' scores in the diagnostic tests taken by the students attending the group of schools that started implementing the Alef Platform in 2018 with students' scores in schools that started to implement the Alef Platform in 2019. These diagnostic tests were conducted for three different subjects, and the results from analyzing these tests scores include all three tests; there is enough evidence of over a 95% confidence interval to suggest that the Language diagnostic test scores are greater for 2018 than 2019 schools; there is also enough evidence of over a 95% confidence interval to suggest that the Reading diagnostic test scores are greater for 2018 than 2019 schools and more evidence of over a 95% confidence interval suggests that the Science diagnostic test scores are greater for 2018 than 2019 schools. Furthermore, the students attending the 2018 group of schools score better in the Math diagnostic test when compared to the students in the 2019 group of schools. Overall, we can see from the analysis of the different types of diagnostic test scores and the final exam results in all subjects that there is a statistically significant difference between 2018 students and 2019 students, specifically that the students in the 2018 schools have greater scores in the diagnostic tests and MOE’s final exams. This gives a very high value and validity to this finding because the analysis compares between the two groups of schools using different instruments, which are the data from the Alef Platform, the MOE’s final exam and the diagnostic tests, and all data results in the same finding - the schools that used the Alef Platform for a longer period of time obtain greater results. This proves that the Alef Platform has a positive impact on improving students' learning and performance. The analysis results of the data collected from the teachers’ survey support this finding and explain the reason behind it, as shown in later sections below.

The results from analyzing the teachers’ survey, for both closed-ended and open-ended questions, support this conclusion. The results of the analysis of the closed-ended questions show that more than 85% of the respondents believe that the Alef Platform improves students' learning and their learning outcomes. The data collected from the open-ended questions further support this finding as the responses indicate that the students love the interactive learning materials on the Alef Platform, which helps improve their learning outcomes. The finding of the research conducted by Sahronih, Purwanto & Sumantri (2019) upholds this suggestion as their results show that interactive learning materials have a positive impact on students' learning outcomes. In research conducted by Quadir, Yang & Chen (2019) on the effect of interactive methods on student learning outcomes, they suggest that there is a significant correlation between the student to student and student to content interaction and the objective learning outcomes. This finding conforms to the social constructivism theory, which suggests that learning occurs upon interaction with the learning materials and the surrounding environment (Mucundanyi 2019). This finding also proves one of the benefits of blended learning mentioned by Graham et al. (2019), which suggests that interactive online digital learning material grants students the opportunity to access and interact with this learning material at any time and anywhere, which contributes to improving their learning.

Additionally, 80% of the teachers believed that the Alef Platform helps students to discover new content and build new skills. Ajaj (2020) found in her research on how the use of digital platforms encourages learners toward improving their English language skills that digital platforms create a powerful environment that supports and encourages students to learn and develop their English acquisition processes. Ajaj (2020) suggests that "E-learning is a technological advanced learning pattern that positively influences English language acquisition and improves the English language skills and abilities of learners" (P.12).

In addition, more than 75% of teachers believed that the Alef platform enhances students' discipline and behavioural problems, which could lead to improved learning as well. Manolev, Sullivan & Slee (2018) support this finding as they found in their research that the digital learning platforms that personalise learning and provide interactive learning materials improve the student behaviour and shift the teachers’ role from controlling the students’ discipline to engaging them with the learning activities and that such platforms help with distributing the power between students and teachers to increase the students’ sense of responsibility toward their learning. Li, Yamaguchi & Takada (2018) found in their research that there is a strong positive relationship between interactive learning materials and internal and extrinsic motivation and learning satisfaction, which promotes the students’ ability to manage their learning timing and discipline. This finding supports one of the benefits of blended learning indicated by Graham et al. (2019) to suggest that blended learning using online digital learning tools promote students’ responsibility towards their learning by giving them control over the time and place that best fits their learning circumstances.

The responses to the open-ended questions second this suggestion as many of the responses explained that the Alef Platform enhances the students' knowledge by providing students with rich and visual resources of learning materials, such as videos, audios and simulation and interactive activities. This finding conforms to the significant learning components and keys, as reported by Anderson (2008) based on learning theories and mentioned earlier under the Theoretical Framework section. These keys and components should be recognized by any designer of digital learning material (Anderson 2008).

Güney (2019) agrees with this statement as he mentioned in his paper that visual learning is important to improve students’ learning, so the learning materials should include design variables in the instructional design process following the learners’ information processing model; that includes seeing and hearing these variables in order to promote the learning process. The designers working on the Alef Platform should always put into their consideration the design principles of educational materials; according to Güney (2019), “visual and instructional designers and multimedia, designers should also be aware of the design considerations for multimedia projects, lessons, software developments, visualization types for learning imagery, and user interface design principles” (P. 114).

In their participation in the open-ended questions, the teachers refer to another reason behind the Alef Platform’s contribution to the improvement of student learning, which is that the Alef Platform allows students to learn at their own pace and their own speed with various learning resources provided by the Alef Platform. Kaufman (2019) supports this statement by claiming that each student’s ability to learn is different and that students learn in different ways, so focusing on personalized learning and individual students’ specific needs, such as their speed, pace and way of learning, improves students' learning. James (2019) suggests that promoting students’ success can be driven by understanding the student’s ability to learn. This finding points in the direction of the seven principles of student improvement in learning created by Richard Elmore (Elmore 2008) based on his conceptual framework, which focuses on determining that a student’s ability and level should reflect what tasks they are doing and reflect the result of their improvement. According to Elmore (2008), students’ accountability should be associated with their ability to do the task and their understanding of how to do it and the objective behind doing it.

Another reason that was indicated by respondents to contribute to the improvement of student learning using the Alef Platform in their answers to the open-ended questions is that the platform develops independent learning in students as it enables them to learn and control their own learning. These findings are once again consistent with the seven principles of student improvement in learning, as reported by Richard Elmore (Elmore 2008).

According to Kaczorowski, Hashey & Di Cesare (2018), using new technologies and platforms promote students' self-regulation and independence; hence teachers should understand the need of shifting the control to the students so that students are able to take responsibility for their own learning with the support and guidance of their teachers.

The Alef Platform provides immediate feedback and prompts, if needed, to the student within the interactive learning materials in each lesson to help students to construct their knowledge. In the open-ended questions, the responses refer to this instant feedback and hints as a reason that supports students and improves their learning by enabling them to learn from correcting their own mistakes. This finding is consistent with the principles of social constructivism, which proposes that students should take a positive attitude towards making mistakes as something to learn and develop from and not something to fear (Mucundanyi 2019). Furthermore, this finding confirms one of the seven benefits of blended learning mentioned by Graham et al. (2019), that is, the benefit to practice with feedback, which illustrates that students improve their learning from the relevant and immediate feedback they receive while using online learning tools.

The finding of the research done by Azcona, Hsiao & Smeaton (2019) supports this claim as they found that the gap between high-performing and low-performing students was reduced by the predictive and personalized feedback provided to students, indicating that the students who follow the practices recommended to them by the platform, which is triggered by the recommendation engine in the AI platform perform better in the exam. In conclusion, there is sufficient evidence to suggest that AI-driven platforms improve students' performance, especially if they use the platform consistently and utilize all the features on it, such as recommending practices to be sent to students on the platform. This finding conforms with the importance of the adaptive learning system and attempts to personalize the learning experience for the learner, explained previously under the Theoretical Framework section.

5.3 How digital learning increases students' learning engagement

This section discusses the Alef Platform and its impact on students' engagement. Direct and indirect relationships between many factors that are related to students' engagement with the learning materials were examined by analyzing the students' behaviour and learning journey during one academic year. Three null hypotheses were used to examine the relationship between implementing the Alef Platform and students' engagement, as presented in Table 5.2 below. The findings from these hypotheses are to be linked to the results from the teachers' survey, including both the closed-ended and open-ended questions, which were used to explore the Alef Platform and its impact on students' engagement from the perspective of the teachers.

Table 5. 2 The Hypothesis related to students' engagement

2. To what extent does digital learning impact students' engagement?			
No	Null hypothesis	Analysis closure	Alternative hypothesis/closure
2.1	There is no relationship between the time spent on the formative assessment and the average score achieved in it.	Rejected	There is a strong relationship between the time spent on the formative assessment and the average score achieved in it.
2.2	There is no difference in students' average time	Retained	The average time spent by students per stage on the Alef Platform by

	spent per stage between the 2018 group and 2019 group of schools.		the students in the 2018 group and the students in the 2019 group of schools is the same.
2.3	There is no difference in students' number of lessons completed between students in the 2018 group and 2019 group of the school.	Rejected	There is a difference in the number of lessons completed by the students in the 2018 group and the students in the 2019 groups of schools.

With the aim to examine whether the digital content on the Alef Platform motivates students to engage with it or not, the three hypotheses in Table 5.2 try to understand if there is a relationship between the time spent on the Alef Platform on the formative assessment and the average score achieved in this assessment; it also compares between the students’ time spent per stage on the formative assessment and the number of lessons completed by students in the 2018 and 2019 group of schools. The results from the data analysis show that there is a strong relationship between the time spent on the formative assessment and the average score achieved in it. This means that students who are engaged with the content and the learning material got a greater score than students who are skipping some content or went through it very fast. The results for hypothesis 2.2, in Table 5.2, suggest that there is enough evidence to suggest that over a 95% confidence interval in the average time spent per stage on the Alef Platform is similar for both 2018 and 2019 schools. However, the results of the testing hypothesis imply that the 2018 schools’ students completed more lessons compared to 2019 in both academic years, meaning that students in the 2018 group are more engaged with the Alef Platform’s learning content and games than the 2019 group. In addition to that, the teachers’ survey analysis suggests that 80% of the respondents believe that the Alef Platform increases students’ engagement with the learning materials. The

Alef Platform includes, in addition to the educational digital content, built-in educational games aimed at engaging and motivating students to learn. There are many participants in the open-ended questions that support this claim, as some participants mentioned the interactive content and the game-based learning on the Alef Platform increase students' engagement with the learning material. This finding confirms the findings of Hawlitschek and Joeckel (2017), as they claim that there is a positive relationship between digital games and students’ motivation, engagement and accordingly maximized learning outcomes. This finding also confirms the findings of Shute et al. (2015) as they found that using learning games engages and motivates students and improves their learning outcomes, especially if this material is well-designed. Kaewunruen (2019) supports this finding by claiming that interactive learning materials positively prompt students’ engagement and motivation to learn. Also, Santos-Villalba et al. (2020) suggest that gamification is considered as a technique to promote students’ engagement with the learning process.

In conclusion to this section, there is evidence that proves that AI-platforms increase students’ engagement with the learning process, particularly if the content in the platform is well-designed with a consideration of all the educational content design principles. These findings conform to the principles driven by the connectivism theory, which explains how to design digital learning resources.

5.4 How AI digital learning Platforms impact teachers’ practice and perceptions

This section shows the discussion about the finding of analyzing quantitative and qualitative data collected with regards to the impact of the Alef Platform on teachers’ practice. The comparison between the teachers’ who work in the group of schools that started to implement the Alef Platform in 2018 and their colleagues who work in the schools that started using the Alef Platform in 2019 in the time spent using the platform was examined by analyzing the average time spent by the teachers using the Alef Platform and comparing between the average time spent by each group as shown in Table 5.3 below. The findings of these hypotheses are to be linked to the results of the teachers' survey, including both closed-ended and open-ended questions which were used to explore the impact of the Alef Platform on the teachers' practice from their own perspective.

Table 5. 3 The hypothesis related to the teachers' practice

How does the implementation of AI in digital learning impact teachers' practice?			
No	Null hypothesis	Analysis closure	Alternative hypothesis/ closure
3.1	There is no difference in the usage of the Alef Platform between teachers in group 2018 and teachers in group 2019.	Rejected	There is a difference in the usage of the Alef Platform between the teachers in group 2018 and the teachers in group 2019.

The hypothesis test suggests that there is significant evidence of over 95% confidence interval to claim that teachers from the 2018 group of schools spend more time on the Alef Platform compared to teachers from the 2019 group of schools. Analyzing the closed-ended questions in the teachers' survey shows that 85% to 90% of the teachers prefer to use the Alef Platform on a daily basis to check students' performance data and monitor students' performance during class time and use rewards to encourage students to learn. More than 85% of the teachers believe that using the Alef Platforms saves their time and effort and decreases their workload. They all agreed that there are many areas where the Alef Platform saves teachers' time and workloads such as by providing a variety of formative and summative assessments in each lesson and grading it automatically, and providing plenty of teaching resources and materials. The Alef Platform pulls teachers away from instructing the student and saves their time and effort to be dedicated to the students who need more focused support. 90% of the teachers also agree that maintaining students’ records and progress reports on the Alef Platform saves the teachers’ time and effort. Additionally, more than 75% of the respondents agree that the Alef Platform shifts the teacher’s role from that of an instructor into a facilitator or coach. Almost 90% of the participants agree that the Alef Platform supports them in tracking each student’s progress during their learning journey and coaching them throughout the process, which empowers them to better manage their classrooms.

The findings of the qualitative results are similar to this finding, as the teachers’ participation in the open-ended questions is similar to the above-mentioned points as summarized below. The teachers' participation suggests that the Alef Platform saves their time and decreases their workload by providing them with teaching resources, activities, and material as well as ready and automated formative and summative assessments. They also mentioned that the Alef Platform helps teachers to better manage the classroom and track students’ progress as it empowers them to observe their students from a distance and make sure that they are learning and following the teachers’ instructions during the lesson. Tracking students’ progress also enables them to understand the students' level and provide support to students based on their needs. The AI-Powered platform helps teachers to transform from giving traditional teaching and learning to be more as a coach or facilitator, so lessons become more systematic and effective and support them to deliver the required topic in a proper time and way. The findings of the research by Mou (2019) support this finding as it was suggested that AI technology changed the way of learning and that it supports continuous learning, providing teachers with actionable insights on the students' performance to be able to provide better service to their students based on their needs. It also indicated that the AI-driven platform automates the teachers' routine tasks, saving teachers’ time and enabling them to focus on students' learning by making the curricula more relevant to students' level and needs. Holstein, McLaren & Aleven (2019) proposed a similar suggestion stating that immediate feedback about students' progress with students' areas of struggle given to the teachers enables teachers to provide solution paths to students and make teachers avoid interrupting students during their learning process if students don't need help. Without this immediate data and feedback, teachers used to physically walk between students to observe their work and give them feedback. Zhao & Liu (2018) agree with this statement as they mentioned that "the great purpose of human use of AI is to free itself from the complex basic work to engage in more important or more interesting things. But education is very special. It has two parts: teaching and education. Teaching refers to the transfer of knowledge, this part of the work AI can do better than people; education refers to the cultivation of character, encourages students to explore the unknown, to discover, to create, to love, this part is hard to replace by AI" (P.50).

Several teachers proposed that the training they got on how to best implement the Alef Platform, which was provided either through digital courses on Alef Academy or face to face, supported them to better use the Alef Platform and to keep up with any update in the platform. The teachers emphasize the importance of the ongoing training and professional development courses, whether conducted digital or face to face. Marienko et al. (2020) indicated that professional development is significant, and with the implementation of any new platforms or adaptive learning systems, the teachers' training should be considered as a priority. This finding is consistent with Yeigh et al. (2021) and Graham et al. (2019) in their claim that teaching in a blended learning model requires acquiring four core teaching skills which are: online integration, data practices, personalization and online interaction. So, in order to implement it successfully, it is very necessary to organize teacher training workshops to raise teachers' confidence in their capabilities once the implementation starts.

In conclusion to this section, the overall finding from all the data related to the question "How does the implementation of AI in digital learning impact teachers' practice," is that the AI-powered platform plays a vital role in supporting teachers and transforming their practice from a traditional way of teaching and learning to be coaches and that the platform empowers them to serve their students in the best way. However, continuous training and professional development is a must to ensure the maximum benefit from the implementation of any AI-powered platform is granted.

5.5 The role of AI-powered platforms during COVID-19

This section discusses the role of the Alef Platform during the COVID-19 situation. Multiple null hypotheses examine the difference in the usage of the Alef Platform from three dimensions; the average of the time spent, the average of the number of completed lessons and the average of the summative assessment score before and during COVID-19, as presented in Table 5.4 below. The researcher aims to understand the role of the Alef Platform during Covid- 19 on students' learning. The findings from these hypotheses are to be linked to the results from the teachers' survey, including both the closed-ended and open-ended questions, which are used to explore the role of the Alef Platform during the COVID-19 situation from the teachers' perspective.

Table 5. 4 The hypothesis related to the student journey on the Alef Platform during COVID-19

How AI-powered digital learning platforms helped students and teachers during the Coronavirus (COVID-19) situation?			
No	Null hypothesis	Analysis closure	Alternative hypothesis/closure
4.1	There is no difference in the average SA score on the	Retained	There is no difference in the average SA score on the Alef

	Alef Platform before and after COVID-19 for students.		Platform before and after COVID-19 for students.
4.2	There is no difference in the average time spent per stage on the Alef Platform before and after COVID-19 for students.	Rejected	There is a difference in the average time spent per stage on the Alef Platform before and after COVID-19 for students.
4.3	There is no difference in the number of completed lessons on the Alef Platform before and after COVID-19 for students.	Rejected	There is a difference in the number of completed lessons on the Alef Platform before and after COVID-19 for students.

From the analytical quantitative data that examine the above hypotheses, the finding can be summarized as follows; there is no difference in the average summative assessment score on the Alef Platform before, and after COVID-19 for students; however, there is enough evidence of over 95% confidence interval to state that the average time spent per student is greater during the pandemic versus before the pandemic; there is also enough evidence of over 95% confidence interval to state that the number of completed lessons per student during the pandemic is greater than before the pandemic. The qualitative analysis supports this finding as the teachers' survey analysis shows that more than 90% of the participants believe that the Alef Platform supports teachers during the remote learning that happened amidst the COVID-19 situation. In general, and based on these analyses, the Alef Platform played an important and vital role to ensure the continuation of the learning system during the COVID-19 situation. The qualitative data supports this statement as the teachers' participation in relation to the Alef Platform's role during COVID-19 was that the Alef Platform provides incredible support because it provides fully explained learning material that is presented in various format, such as videos, games, formative and summative assessment activities, to help students master the learning material and allows following more than one learning style whether from the teachers' end or the students', whenever and wherever they want to study. It also enables teachers to monitor students from a distance and make sure that they are learning and following the teacher during the digital lesson while tracking all students' progress through the platform to provide students with the needed feedback based on their needs. Several teachers' responses also indicated that the most important thing that is supporting students is that all the six core subjects are available on the Alef Platform so that students can easily move from one subject to another, and teachers can compare the students' progress in all six subjects, which gives them an insight into students' progress, area of struggle and ability. It is a well-known fact that AI-powered platforms are necessary to avoid any interruption in learning during natural disasters and crises.

5.6 Thesis contribution

The current thesis contributes to the field of educational research as it proposes an analysis of a large sample of 7,039 students, 512 teachers and 12 schools, using the mixed-method approach, which represents a combination of the quantitative and qualitative analysis. In addition, this thesis is one of the first to be written in the world and the first in the UAE about Artificial Intelligence in Education and its impact on students' learning and teachers' practice, which makes it a significant contribution to the existing research literature.

Research papers usually focus on either the teacher or the student; however, this thesis covers both the teachers and students, who represent the most important pillars in the education sector.

This thesis also contributes to the existing literature with a teachers' survey that can measure the teachers' perspective towards AI-driven learning platforms. Furthermore, this study is one of the few that discuss education amidst the COVID-19 pandemic and proposes solutions to help ensure the continuation of learning during such natural disasters.

5.7 Recommendations

It's high time for the education sector to celebrate the AI benefits by implementing AI adaptive systems in the educational system to support all stakeholders, the students, the teachers, the school leaders, the parents, the decision-makers and the Ministries of Education. One of the benefits of AI in education is the ability to conduct high-quality distance learning. The researcher recommends that parents and learners are offered more flexible options of learning, between digital distance learning, learning at school or a hybrid model that allows for an alternation between digital and in-person education. This will lead to a reduction in the number of school campuses, the congestion on the roads at the start and end of school hours, and the sustainability of the environment.

As artificial intelligence offers adaptive and personalized learning, knowledge gaps can be detected ahead of time by AI-enabled technologies based on huge amounts of collected data on the students throughout their learning journey. Before the dawn of AI and Big Data, students' performance used to be a mere black box, whereas AI and big data gave more clarification to the decision-makers on the comprehension level of students and whether the curriculum at their hands meets their abilities, not exceeds them. Therefore, governments and ministries of education all around the world should celebrate this benefit that is provided by AI to promote the educational system and rethink the curriculum, standards and learning outcomes and to continue updating it according to the students' performance in these curricula. Such data can provide guidance on the professional skills and talents that students have, which the parents and decision-makers can use to steer the students and the youth to the right career path.

The researcher also proposes some recommendations to the developers of the AI-driven digital learning platforms to follow the fundamental principles of building educational tools, resources, educational games, and learning materials. Moreover, the developers should create a feature on the learning platform that opens virtually private communication between the students and the teachers to enable students to ask the teacher questions freely and comfortably or to request their support.

The teachers should also leverage all the benefits that AI-driven platforms offer to them and their students and to continue their professional development to stay abreast with the new updated features and to be fully aware of the purpose of all the tools and resources made available via such platforms.

In conclusion, the researcher advises that the Alef Platform becomes inclusive of all school subjects, such as Information Technology, Arts and Music and that the Platform is defined as a national and global project on all school subjects from grade 1 up to grade 12, with the aim of creating a comprehensive virtual learning ecosystem to support and ensure the continuation and sustainability of learning in cases of natural disasters anywhere around the world.

5.8 Study limitations and further research

This study has a number of limitations; one of the limitations is the fact that not all school subjects are covered where the Alef platform included core subjects only. For instance, the Alef Platform is used to teach only the six core subjects, namely, Arabic and English languages, math, science, Islamic studies, and social studies. Other subjects, like arts, physical education, IT, and music, are not included in this study. In addition, this study is based on data collected over a relatively short period of time. This study can be further extended to observe how the students' performance and skills develop over the years and to draw a comparison between those students and students who learn in a traditional fashion. The study can also be further strengthened by incorporating the perspectives of curriculum and learning material designers, parents and policymakers, which can shed some light on the rationale for including particular types of tools in the product.

Further research could be done to compare the teachers' implementation of AI-powered digital platforms, showing different teaching styles as the performance of one teacher could differ from the other teachers; some teachers have more experience adopting online tools compared to others.

There could be other ways to investigate student engagement with the learning material, in addition to the time the student spends on the platform, in order to have a deeper understanding of how AI-powered learning contributes to students' engagement. Another instrument that could also be used to acquire a better understanding of how AI-powered platforms improve student learning, such as, students' survey and parents' survey.

Further research on the impact of AI-powered learning platforms on school leaders, Ministries of Education, decision markets and governments should be conducted to learn how to maximize the benefits of artificial intelligence in the education sector.

5.9 Conclusion

This thesis explores the impact of AI-driven platforms on the students' performance and the teachers' practice through the mixed-method approach. The findings of this research can be summarized as follows; AI-powered platforms help students improve their learning and increase students' engagement with the learning materials and content provided that these platforms are well-designed and developed in accordance with the core principles of educational materials' design. The thesis also indicates that AI-powered platforms support teachers to provide the best services to their students by automating the routine tasks, which reduces the teachers' workload and saves their time so that they can fulfil their students' individual educational needs. Lastly, these types of platforms have become a necessity to ensure that learning does not stop as a result of any natural disaster.

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Appendices

Appendix 1: Overview of the Alef Platform

This section provides an overview of the Alef Platform and the purpose of including this section in the thesis is to understand Alef AI Platform and how it works. Alef Platform is also the case study of the thesis, and it starts with presenting the student's journey to illustrate how students use this platform and the features provided to the students on the platform. Then it shows the teacher's journey and how teachers implement this platform in their classes by using the analytical data that the Alef Platform provides them. The teacher journey also includes Alef Academy, where teachers receive their continuous professional development. After that, it shows Alef Guardian Application that is dedicated to parents so that they can observe their children's work on Alef Platform. Finally, this section gives an overview of the different AI applications and how they work to support student learning, such as diagnosing, adaptive learning and Alef AI recommendation engine.

How does the Alef Platform work?

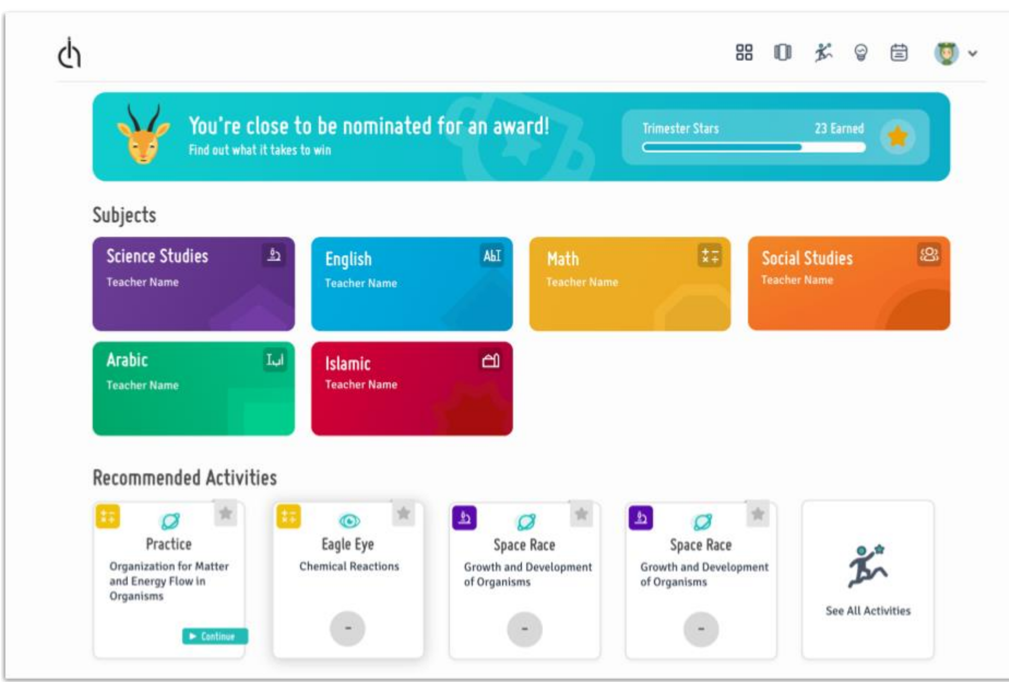
The Alef Product suite supports different stakeholders in the educational ecosystem; students, teachers, principals, school administrators, guardians, educational experts and content production (Alef Education, 2020). As shown below, each stakeholder is represented in the platform and all have their own user journey tailored to the needs of that role.

Student Journey on Alef Platform

The Alef platform provides personalized learning experiences for all students (Figure 1), so they learn at their own pace, anytime and anywhere, while hands-on experiments allow them to test the academic concepts they learn in the classroom.

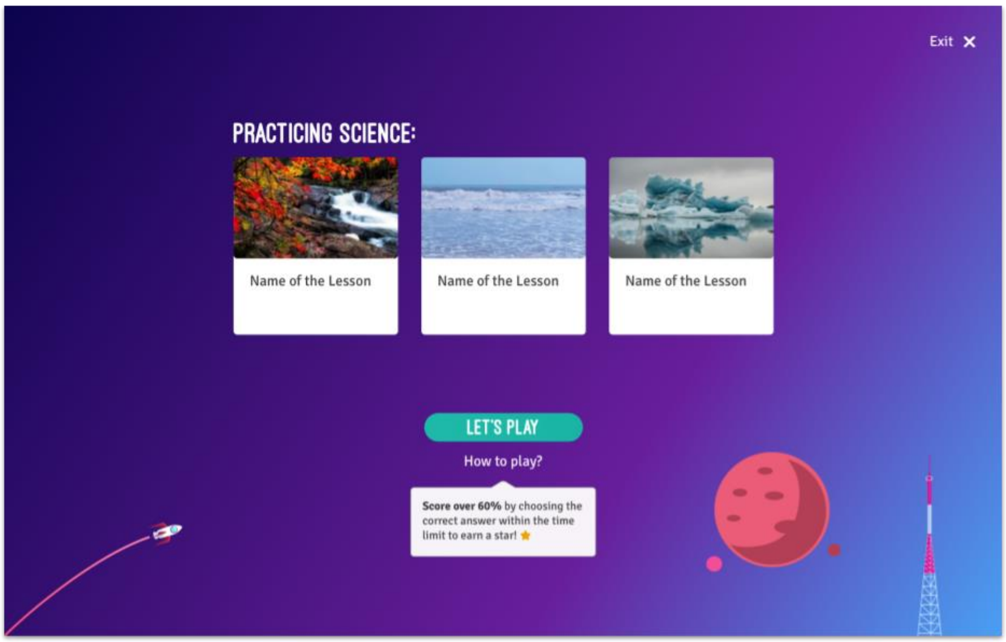
Alef's digital curriculum is aligned to the UAE MOE curriculum in all 6 core curriculum subjects for Grades 5-9: Arabic, Social Studies, Islamic Studies, English, Math & Science and to US Common Core Standards for Grades 6-8 Math. The lessons include interactives, videos, games, simulations and guided formative assessments with hints and feedback that can be repeated multiple times to practice and master the skill introduced. The lessons also include summative assessments for students to take when they feel they are ready to test themselves on the skill learned.

Figure 1 Home Page of Alef Student Journey



Additionally, the lessons include vocabulary support that a student can access at all times (key terms). These keywords are later reintroduced in small fun games (Figure 2), a time-based quiz or a memory game, to improve retention and allow students to interact with the concepts in a fun and engaging way.

Figure 2 Home Page of Let's Play in the Alef Platform

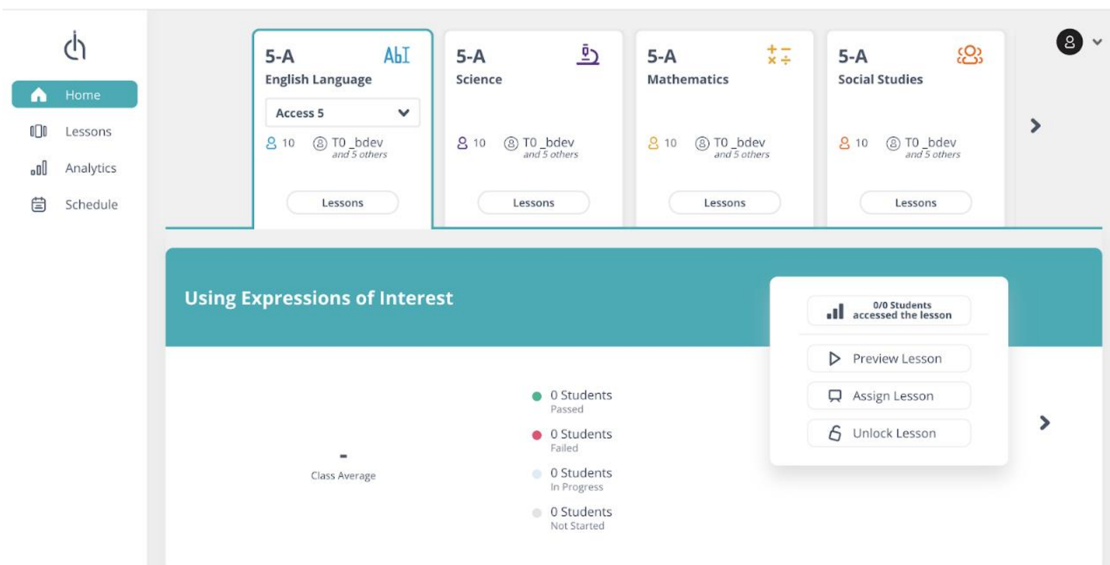


The advanced data models help the product in the aim to improve student outcomes in retention, engagement, and performance. After every lesson that a student completes on the platform, the mastery of that student is recalculated. Students that do not master concepts within lessons are offered prerequisite practice so that they can strengthen previous skills before moving on to the next lesson. In order for students to keep learning and understand their progress, the journey has a structural gamification mechanism that awards students stars for their efforts and accomplishments.

Teacher Journey on Alef Platform

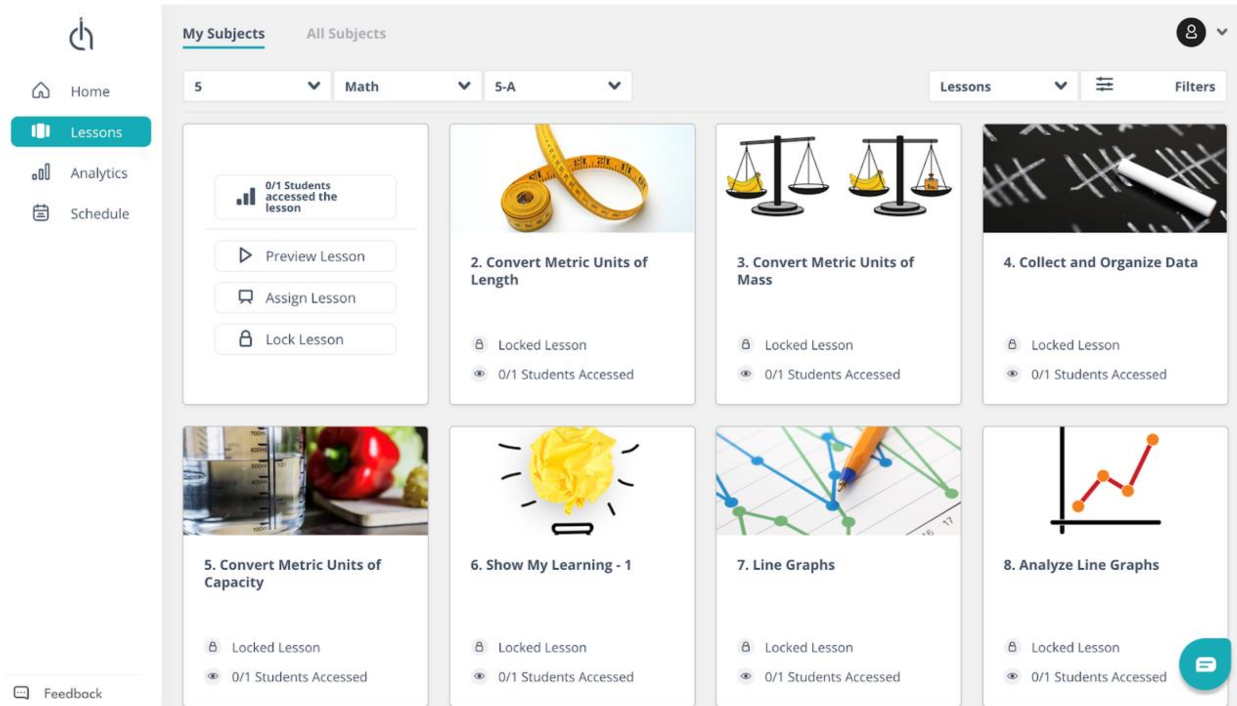
On the Alef Platform, teachers have unique journeys that are totally different from that of a student. In their account, teachers have all the necessary information and data on their students' performance and progress. As shown in Figure 3 below, Alef Platform enables the teacher to view all the subjects available on the platform for all grades without restriction to the subjects or classes that the teacher is appointed to teach, to cross-curriculum links between the different subjects where needed. However, to protect the privacy of the students, teachers are only able to access the data that is related to the performance of their students only and they cannot access the profiles, data or any piece of information on any student that they do not teach in their class.

Figure 3 Home Page of Teacher Journey in Alef Platform



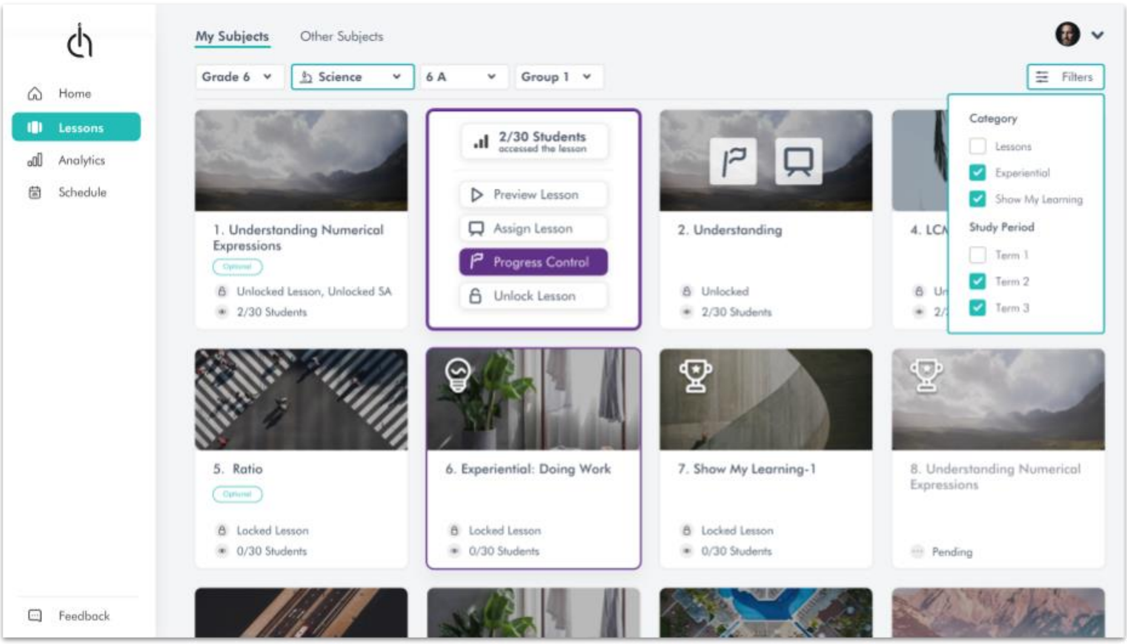
The below Figure 4 shows the lesson page for the teacher where s/he can view the lesson bank for the different subjects. The teacher can also use the filters available on the page to access lessons by grade, subject and section. On the window, the teacher can see lesson cards to preview, assign or lock a lesson.

Figure 4 Teacher Lesson Page



The teacher can have full control over which lesson is assigned to which student or class, as shown in Figure 5 below. However, they can also allow for all lessons to be accessible. The same logic applies to the assessments within a lesson, a teacher is able to control the access and decide whether or not the students are ready for the next formative of summative assessment. This way a teacher can assign lessons or parts of a lesson as homework supporting the different modes of teaching, i.e. flipped classroom model.

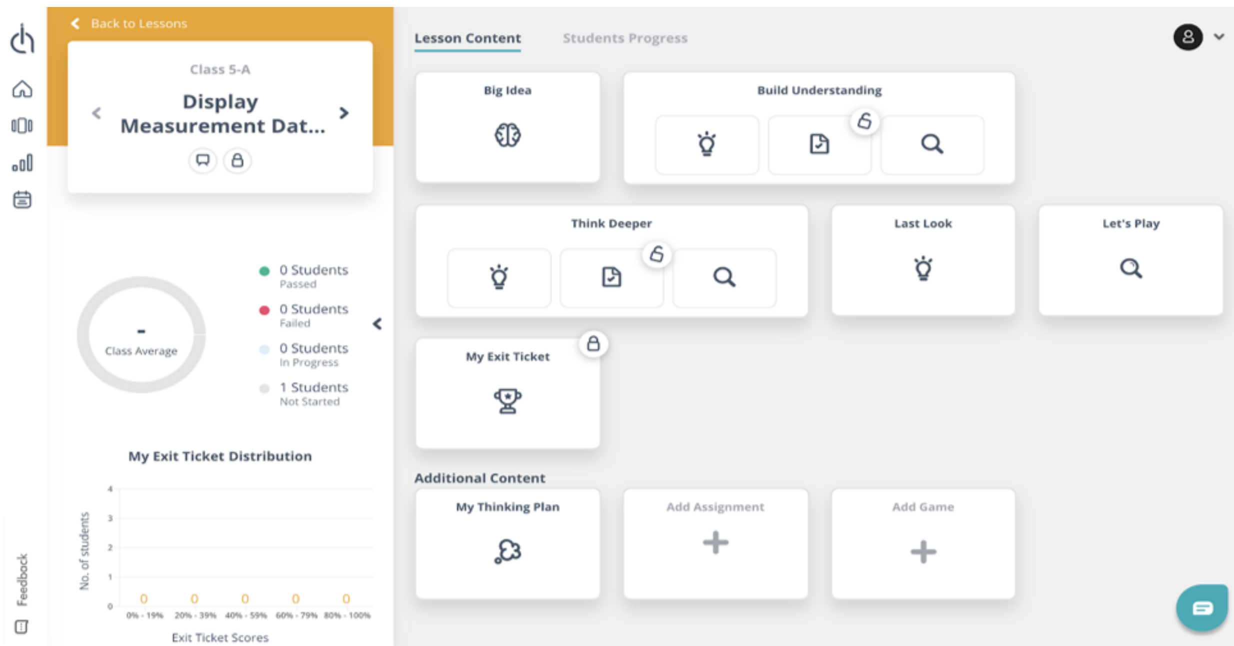
Figure 5 Control Features on Teacher Lesson Page



Each lesson on the Alef Platform is broken into smaller learning blocks. The first block, named The Big Idea, introduces and attracts the student's attention to the lesson topic. Each block addresses a specific learning outcome and provides the content in several forms, such as, videos, interactive activities, games, which serve different learning styles. Each content block is followed by a formative assessment to help the teacher track and assess each individual student when needed; if a student doesn't master the learning outcome, the platform guides the student to re-learn through the Second Look, the same content but in a different method provided by the platform, as shown in the below Figure 6. The last block provides a comprehensive summary of the lesson. Each lesson ends with a summative assessment in order to ensure student learning before moving to the next lesson.

In order for students to apply their knowledge, a teacher can create an assignment they want the class to make. An assignment is graded by the teacher. The product also allows for an 'in class' game. These games are designed to pull 5 questions from the original or chosen lesson and are done together with the whole class, the teacher shows the question on their SmartScreen and the students are all allowed to answer within a set time. This allows the teacher to address the class in a fun and engaging way, meanwhile practicing concepts with the whole class.

Figure 6 Lesson Parts on Alef Platform Lesson Page



Alef Platform provides live and comprehensive data on each individual student, class performance, students mapping based on their time spent on lesson, and lesson life data. For example (Figure 7) below shows individual student data across each lesson to allow teachers to have a general overview of students' performance across lessons and understand students' situations and where and when he or she needs help. Teachers can also use this data in parental meetings and build their discussion on facts about students’ performance, which in turn helps make the right decision on how to support individual students.

Figure 7 Class Performance on Alef Platform’s Analytics Page

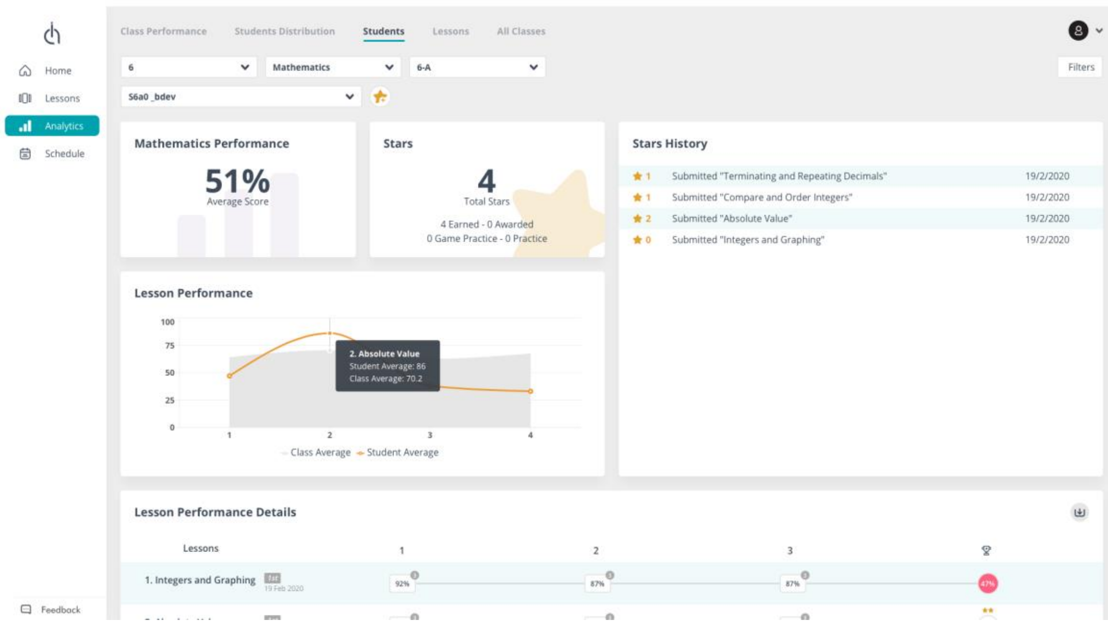
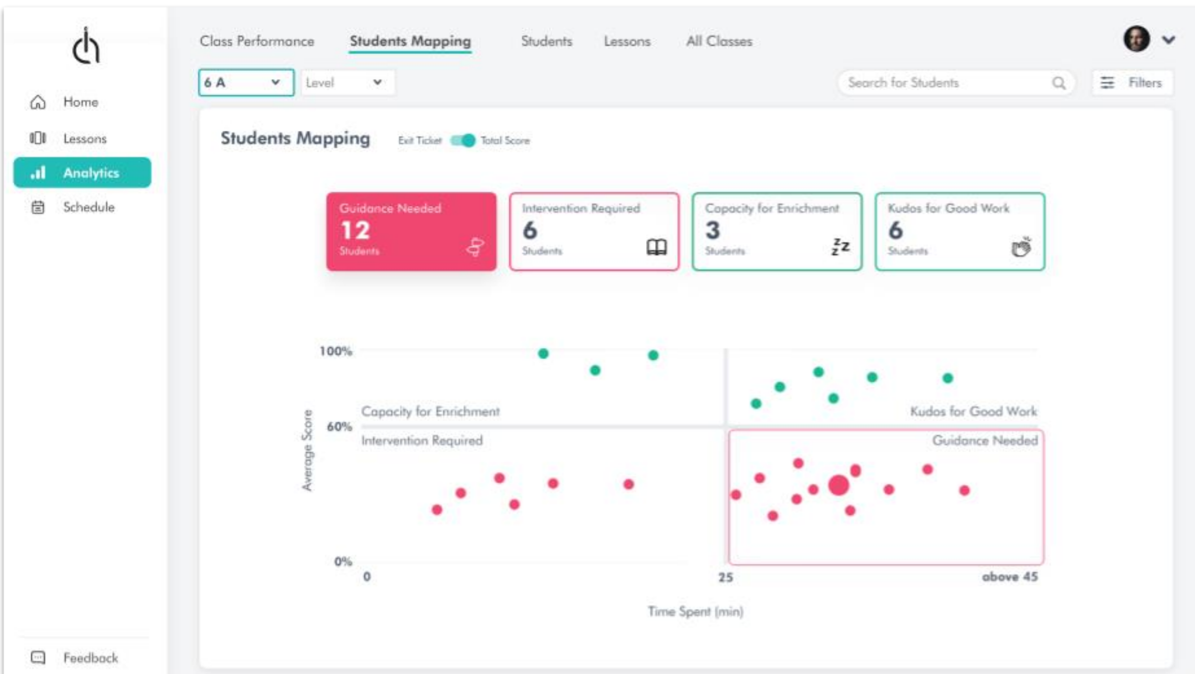


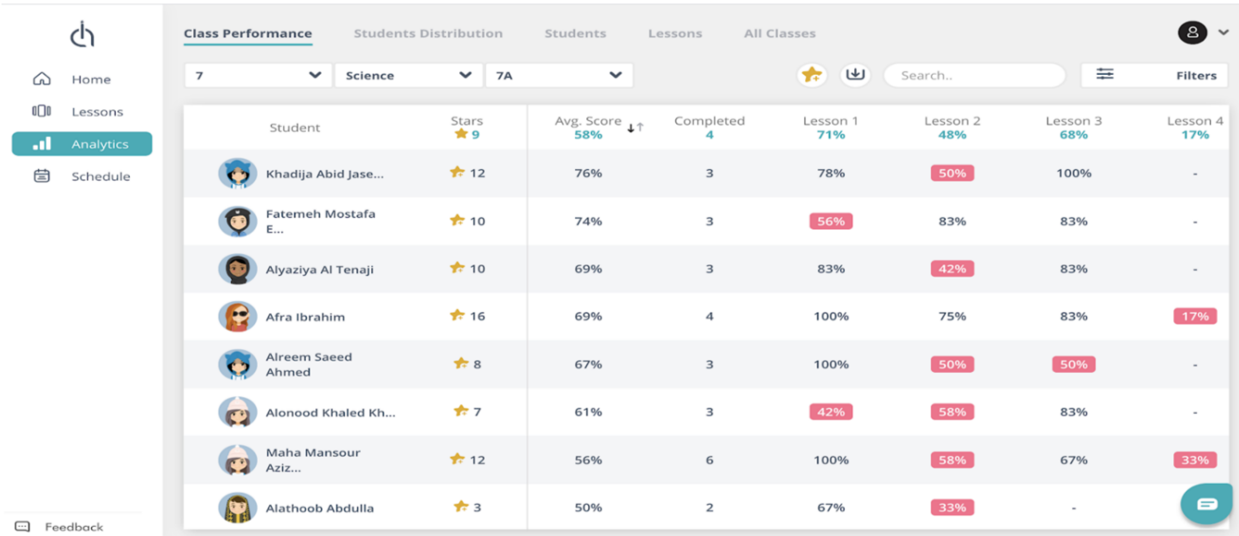
Figure 8 shows how the platform distributes students based on their performance so that the teacher can group students based on their average scores and the time spent to help address various student needs and differentiate accordingly. Alef platform provides data on the whole class and for specific lessons. This data is mapped as the time a student spends on the lesson versus the student's score in the exit ticket for completed lessons. This data also provides an explanation for the students’ behavior during the lesson; for example, some students spend less time and get low scores, which means they might have not given attention to the lesson or could have even skipped the learning materials, or maybe they are just less engaged with this lesson. Another case is students who spent less time but still got very high scores, this shows the teacher that these are high-achievers and that they should be provided with more challenging learning materials. In some cases, there are students who spend more time on a lesson but get low scores; this proves to the teacher that the student is willing to learn but they need more support. Additionally, some students spend an average amount of time on the lesson and get good scores.

Figure 8 Students' Mapping on Alef Platform's Analytics Page



The platform also provides an overview of the whole class performance in every individual lesson as shown in (Figure 9) below. From this data teachers can make a decision if any lesson needs to be reconsidered and taught again. For instance, if all or the majority of a class' students get a low score in any specific lesson, it means that the problem lies in the lesson; maybe it is too difficult for students of such level; the students could also have not been taught the fundamental concepts required to comprehend this lesson; the reason could also be the way the lesson is presented in the platform. In such cases, the teacher can take an action and teach the class the lesson again but from a different approach.

Figure 9 Student’s Performance on Alef Platform’s Analytics Page



Alef Platform allows teachers to see real time data on how individual students perform in each part of the lesson as shown in Figure (9). From this data, teachers can understand if students are moving from a depth of knowledge to another easily or if any of them is struggling. If some students struggle with one part in the lesson, the teacher can directly provide immediate support to these students to help them move to the second part easily.

Figure 10 Lesson Live Data on Alef Platform’s Analytics Page

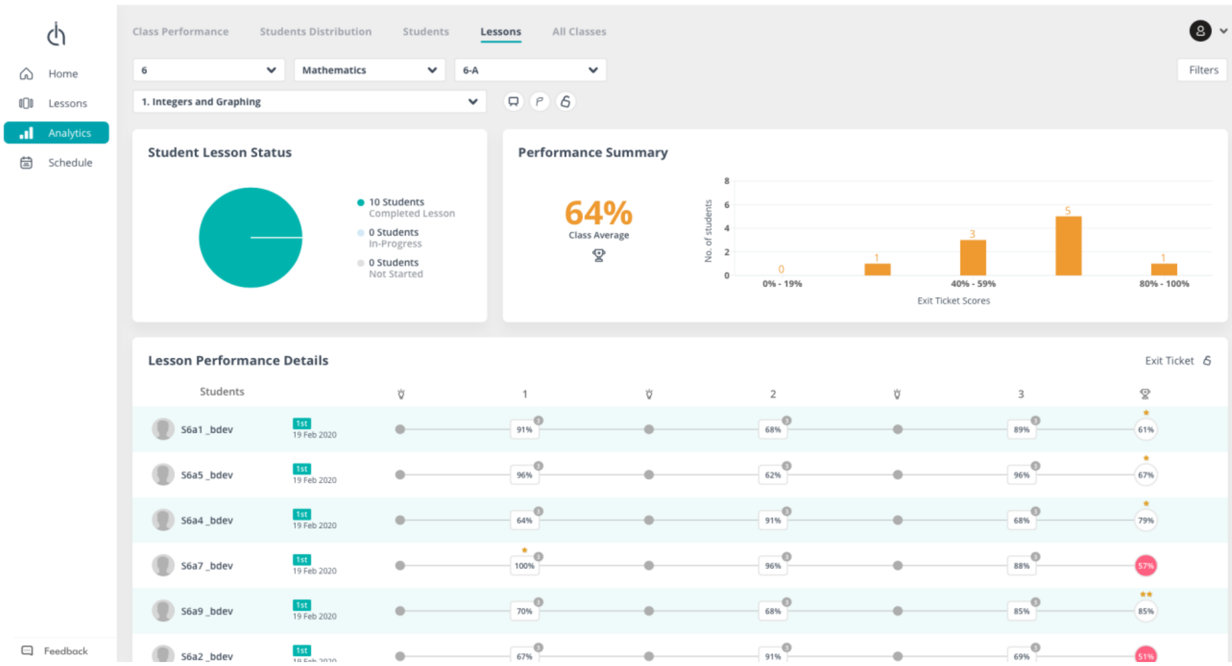
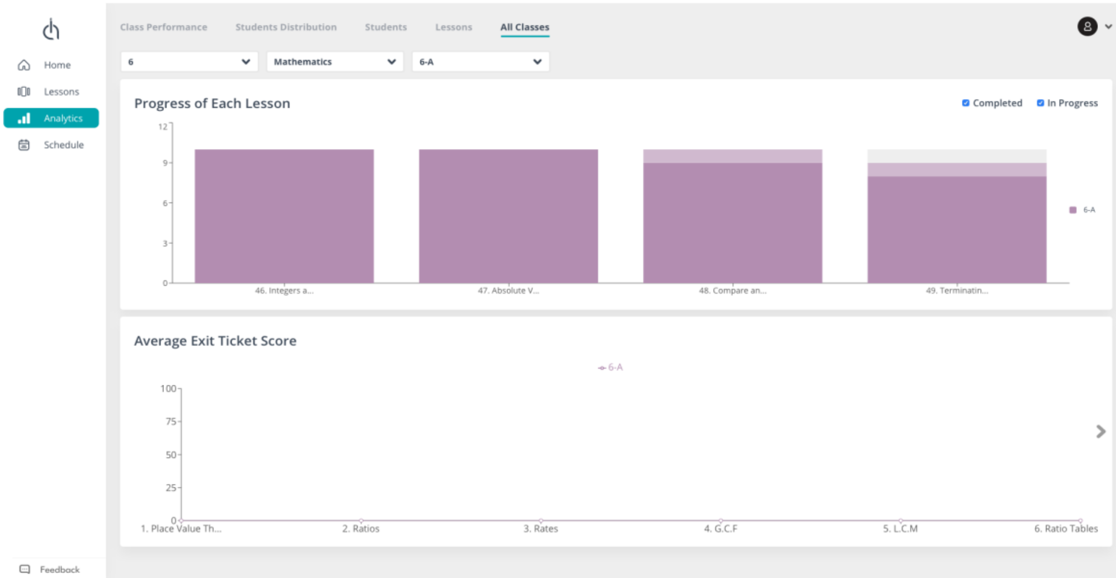


Figure (10) shows how the platform gives the teacher the option to compare the performance of all the different classes. For example, if all classes show low performance in the lesson, this means that the lesson itself is the main element to be addressed. However, if only one class struggles with the lesson, it means that the teacher should explore the causes behind this with this class and provide the solution.

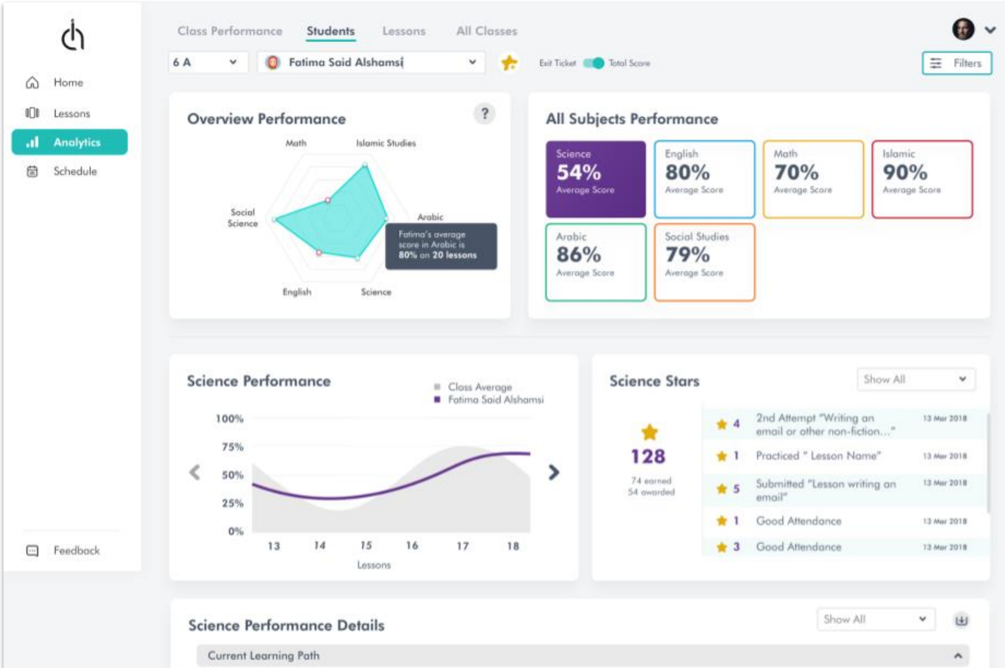
Figure 11 All Classes on Alef Platform’s Analytics Page



In order to provide actionable data and give intelligent and accurate recommendations, Alef collects over 50 million data points per day. The data is at the heart of the analytics that inform teachers and school leaders which students are struggling and what they need help with. Analytical overviews are automatically generated, and assessments are auto graded, which helps in reducing the administrative tasks for teachers, ensuring they can use their time to support their students' learning. The platform allows teachers to follow their students in real time, allowing a teacher to intervene on the spot if necessary.

Teachers are also able to reward students for non-curricular behavior or performance, i.e. great teamwork. These awards are given in the form of stars that a student receives, and the student’s parent or guardian can view. The teacher can write a personalized message to the student as shown in Figure 12 below.

Figure 12 Students’ Stars on Alef Platform’s Analytics Page

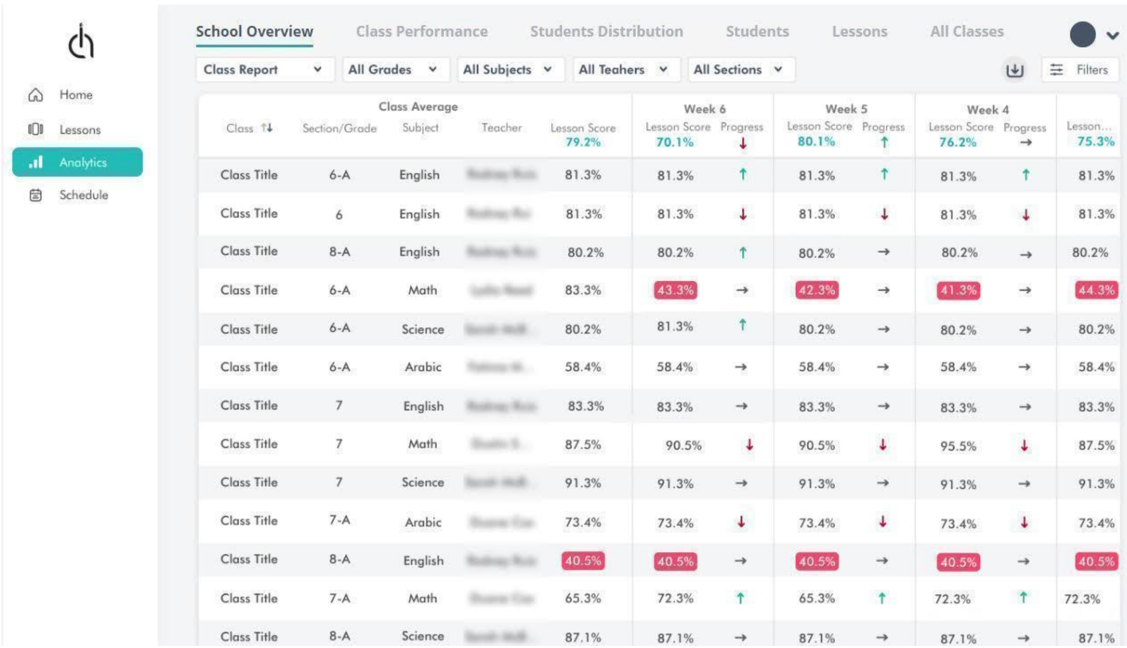


Learning journeys are designed with outcomes in mind, aligning with various curricula and international standards and their end-of-year expectations for student growth and achievement. Assessments are designed according to required depths of knowledge and proficiencies associated with skill mastery.

School Leader Journey on Alef Platform

The school leader has access to all the classes, subjects, teachers and students using the platform in the school, as well as all the data and information on each of these categories. In addition, Alef Platform provides school leaders with data insights on the overall performance of the whole school, Figure 13. This helps school leaders to study the performance of their school and put in place strategies and make decisions based on the data provided by the platform to drive school success.

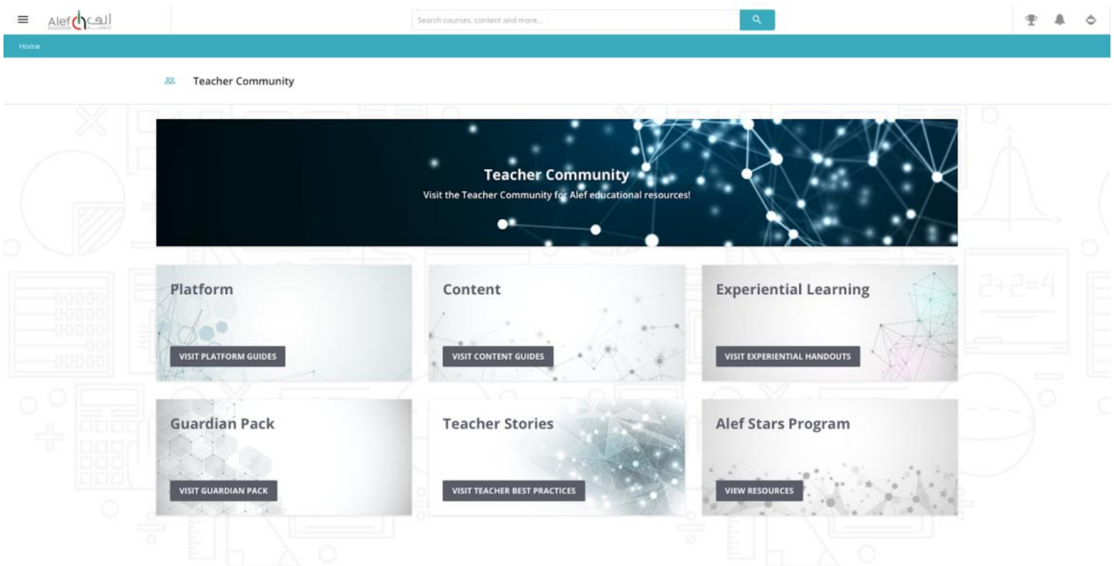
Figure 13 School Leaders’ Analytics Page on Alef Platform



Alef Academy

Alef Academy is a part of Alef Platform dedicated to providing school leaders and teachers with digital professional development courses. Moreover, it enables school leaders to observe the teachers’ performance across classrooms and track their progress in the digital professional development courses. The academy courses are divided into two main types: courses that are aimed at training the teachers how to optimize the platform and each feature on it, as well as courses that focus on developing the teaching methods and strategies and pedagogical skills of the teachers, (Figure 14).

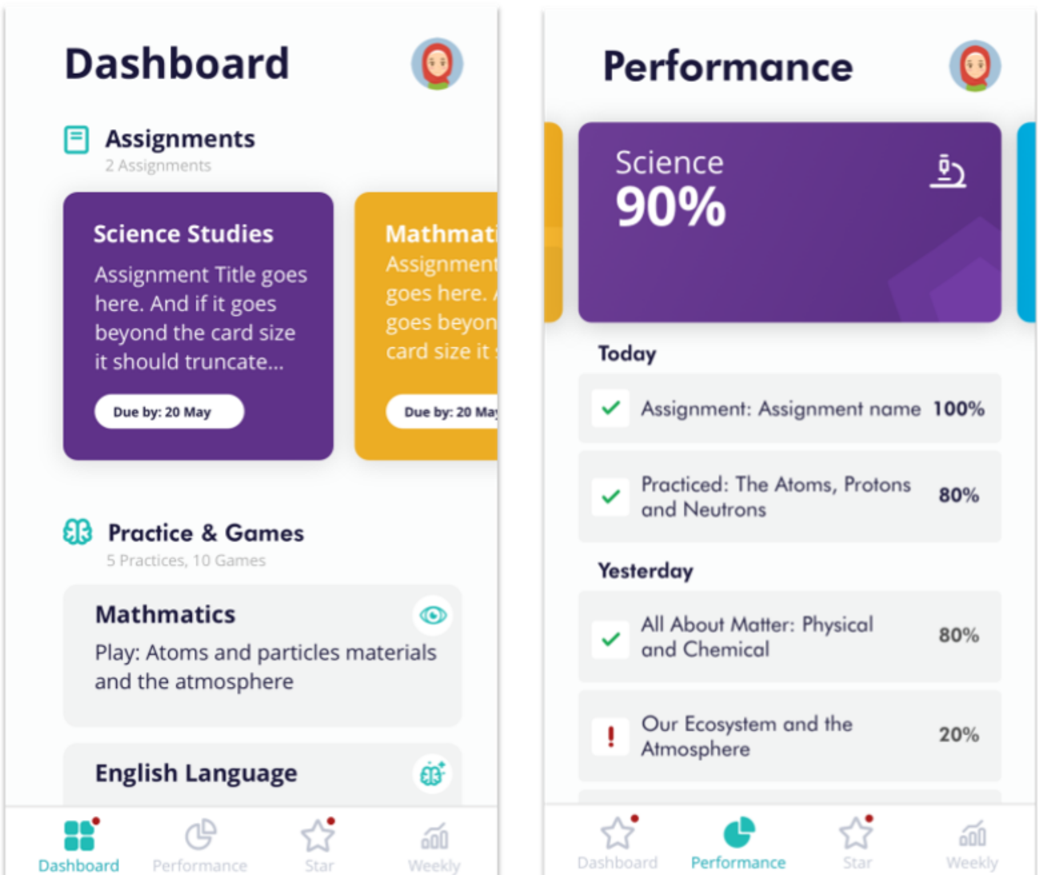
Figure 14 Alef Academy on Alef Platform



Alef Guardian Application

The Alef Guardian app (Figure 15) allows parents to participate in their child's learning journey on Alef. It gives them insights into their child's performance in lessons, an overview of the number of Alef stars the child has been awarded and it also gives access to the child's schedule at school. Parents remain informed with a weekly report on their child's progress and it helps them to identify learning gaps to provide appropriate support to aid their learning.

Figure 15 Alef Guardian Application

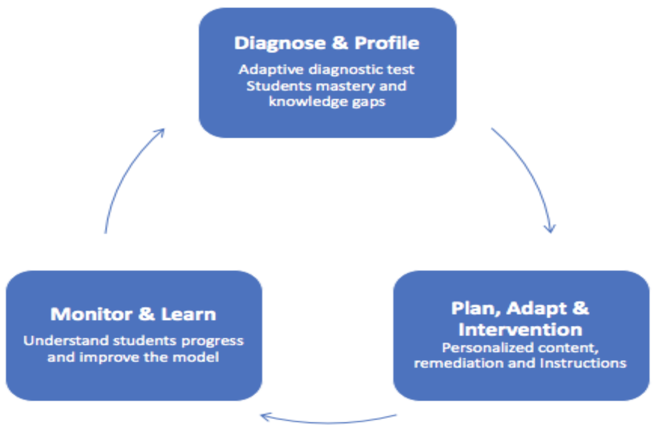


Alef AI Adaptive Learning System

It is obvious that every student has their own abilities, learning style and way of thinking. These differences inspire educators to identify the students' needs and abilities using different teaching methods. In the traditional education system, it is difficult for a teacher to detect knowledge gaps of every individual student and to formulate a specialized intervention for them. Also, in such a system, measuring the hidden cognitive ability of students like mastery is almost not possible. Therefore, the Adaptive Learning model is designed to assist educators and learners to solve the above-mentioned challenges. Adaptive learning is an emerging educational methodology using AI algorithms to adjust the content and instructions based on learner activities and performance.

According to Ali Nadaf, the Head of Alef Data Science Department (Alef Education, 2020), Alef Adaptive Learning is designed based on three main principles. 1. Measuring students' knowledge level and identifying their misconceptions; 2. Personalizing digital learning and teacher-led instruction based on the student's profile; 3. Monitoring student growth over the course of intervention and updating the adaptive learning model. These steps are shown in Figure 16.

Figure 16 Alef Adaptive Learning Cycle



In the following sections, we are going to describe these steps of adaptive learning in detail.

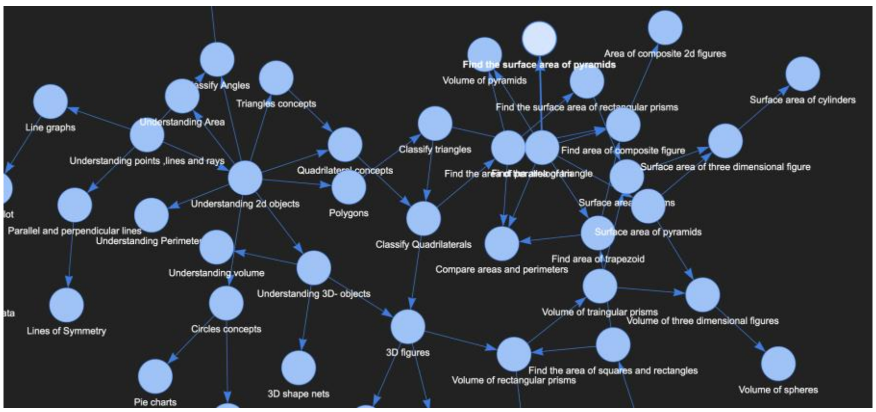
Diagnosing & Profiling

Like other adaptive learning models, the first step is to understand what students know and don't know. In Alef, our data scientists have designed and developed an adaptive diagnostic test using advanced Machine Learning to measure students' knowledge level and their skills gaps. The adaptive diagnostic test is a standardized formal assessment whose questions are adaptively selected by AI based on the student's previous responses. The AI generates questions until it reaches a very clear level of reliability on the test.

The goal of the diagnostic test is to compute the initial knowledge level of students as a baseline.

The test produces Criterion-referenced scores that measure students' knowledge level and their abilities like Scaled Score (SS) and Grade Equivalent (GE). These scores are comparable across multiple grades and multiple tests. In addition to the Criterion-referenced scores, the Norm-referenced scores are calculated to provide a relative measure of student achievement compared to the results of other students who have taken the same test, like Percentile Rank (PR) and Normal Curve Equivalent (NCE).

Figure 17 A sample of Alef Knowledge Graph in Mathematics



It should be noted that Alef is a mastery-based learning platform so that students need to achieve a deep level of understanding of educational skills in order to move on to gain mastery of more complicated skills. In this approach, we need to make sure that students are qualified enough to move forward. The initial mastery level of students is measured by the adaptive diagnostic test for the attempted skills.

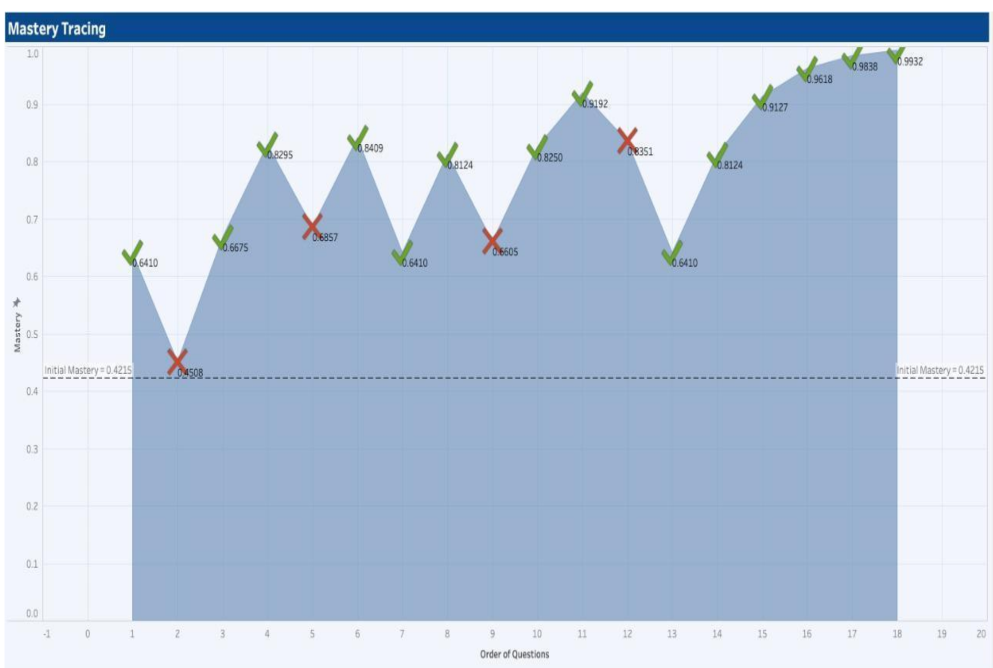
To measure mastery, a structured knowledge base consisting of skills, lessons, and prerequisite relationships among them is required. The relationship is represented as a network-graph called Knowledge Graph (KG) (Figure 17).

Using the Knowledge Graph and knowledge tracing techniques, Alef AI accurately and efficiently determines and traces student's skill-mastery for each subject. Alef determines whether a student has mastered or not mastered a skill and traces the mastery evolution over time. Figure 18 shows the evolution of mastery of a student over time.

After determining the skill mastery level of the student, the student’s skills gaps are computed using based on gap score, mastery decision threshold, the student mastery level and the difficulty level of the skills.

The adaptive diagnostic test uses Alef educational competency framework such as Knowledge Graph, skills catalog, and prior knowledge quantifiers to provide comprehensive insight into student learning across learning skills.

Figure 18 Tableau Visualization of Alef Mastery System

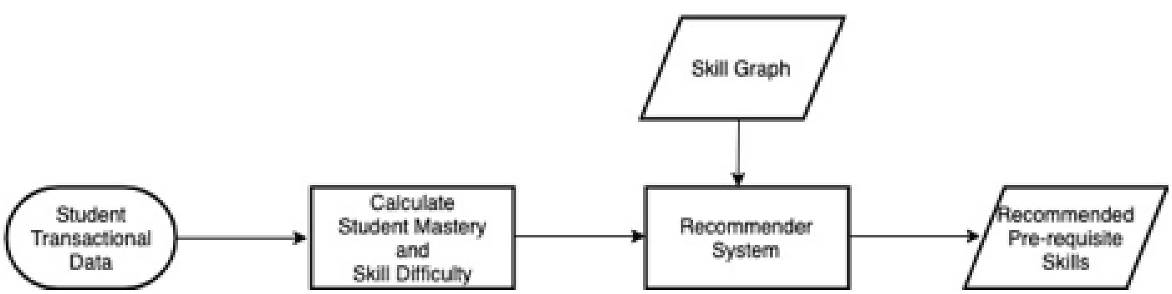


Plan, Adapt & Intervene

In Alef, the AI adaptive learning engine identifies the knowledge-state of students and recommends the optimal learning paths. Alef helps educators not only by providing detailed insights about their students but also by suggesting the adaptive instructions to remediate students' performance. It also informs the teachers about the materials that a given student has difficulty comprehending. The personalized instruction targets skill gaps to help educators and learners to work together to fill those gaps and advance learners to be at grade level.

As already discussed, Alef adaptive learning solution is primarily based on a set of established approaches involving performance factor analysis, and transitive-closure of a skill-graph to recommend pre-requisite skills for a lesson based on the student's current knowledge-gap about that lesson. The Alef adaptive learning system provides pre-requisite skill recommendations tailored towards each student’s knowledge-gap using the student’s skill-mastery, skill-difficulty, and skill-graph as input. A high-level flow diagram indicating the input and output of the recommendation engine is shown in Figure 19.

Figure 19 Input and Output of Recommendation Engine



The engine computes student-mastery and difficulty levels associated with every skill, which in turn, along with skill-graph to generate pre-requisite skill recommendations. In addition, the machine learning models are trained with instructional plan data, provided by teachers and domain-experts, to differentiate interventions.

Monitor & Learn

The main objective of adaptive learning is to personalize the interaction with students and start helping them before they really fall behind. Hence, constant systematic monitoring of student growth over time is essential in this process. This helps learners and educators identify struggling learners early on and give them proper support.

The Alef Platform uses a Curriculum-Based Measurement (CBM) approach to monitor students' progress in specific skill areas. The diagnostic test provides the baseline which is the level of skills the student starts with. The CBM approach helps educators to set clear short- and long-term goals for students.

The Alef Platform keeps tracking students' responses to a certain teaching method or instructional intervention. Students' feedback on the intervention components is used to improve the adaptive learning model and is the last part of the chain to complete the cycle, as shown in Figure 19 above.

The Alef adaptive learning solution identifies the knowledge level of students through a diagnostic test. It uses data to plan and deliver differentiated instructions to learners and educators. It actively monitors and tracks students' progress and updates its own algorithms. Ultimately, the education system benefits from increasingly wide use of adaptive learning in teaching and learning.

Alef AI Recommendation Engine

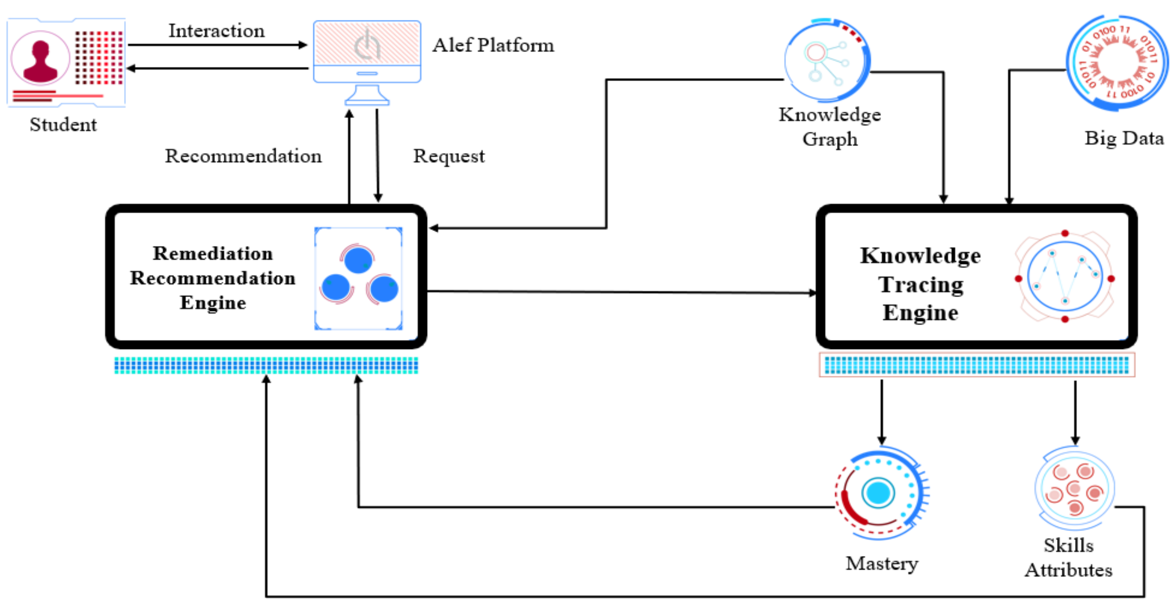
According to Joe El Sebaaly, Director of Product in Alef Education, the Alef Platform generates a number of data points that are processed through the Alef Big Data pipeline.

1. Recommendation engine in Figure 20 uses the input from the knowledge tracing engine to pick the next practice to serve. It takes into account the mastery of the student and the difficulty level of the practice set and whether it is part of the prerequisite path for the student.

2. Knowledge tracing engine uses PFA (Principal Factor Analysis) machine learning algorithm to measure the mastery of students at the skills in the graph it takes as input to the data pipeline which contains all user and content information and the knowledge graph to map the content to the graph. Pfa is a machine learning meaning the results change when given more data from students.

3. Finally, the info is filtered from the engine and some skills are picked for display based priorities. The recommendation engine might pick many skills but Alef is designed to pick a max of three skills whenever something is getting recommended.

Figure 20 Alef Platform's Recommendation Engine



Student Journey with Alef AI Engine

As shown in Figure 20, once the student is captured using the platform, the platform initiates the communication process with the Remediation Recommendation Engine, which in turn redirects it to the Knowledge Tracing Engine.

The Knowledge Tracing Engine is continuously fed with data from the Knowledge Graph and the Big Data provided by the platform. Big Data includes data on the student's performance on the platform, such as, how much time a student spends on a lesson and whether the student goes through the whole lesson or skips through them. The Knowledge Graph helps specify the skills the student has in a certain subject. The data provided from those 2 sources help the Knowledge Tracing Engine make a resolution: whether the student has mastered the skills required for this lesson or if there are any skills the student lacks that needs to be remediated. The Remediation Recommendation Engine then receives the results and accordingly lays out the content for the student in a gradual manner to ensure that the student receives scaffolded content.

This framework represents an ongoing cycle of learning, where the missing skills are not ignored but instead remediated, making sure that the student completes a lesson equipped with all the required skills for the next one.

Appendix 2: Approval Letter from the University

الجامعة البريطانية في دبي

The British University in Dubai

www.buid.ac.ae

12/8/2019

TO: The Abu Dhabi Department of Education and Knowledge

This is to certify that Mrs Aishah Alyammahi with Student ID number 20170168 is a registered part-time student in the Doctor Of Education offered by The British University in Dubai since September 2017.

Mrs Alyammahi is currently collecting data for her research (How AI-Powered Online Education Drives and Improves Student Learning and Teacher Practice in Abu Dhabi Schools)

She is required to gather data through conducting Interviews that will help her in writing the final research. Your permission to conduct her research in your organisation is hereby requested. Further support provided to her in this regard will be highly appreciated.

Any information given will be used solely for academic purposes.

This letter is issued on Mrs Alyammahi's request.

Yours sincerely,

Dr. Amer Alaya
Head of Student Administration

PO Box 345015 · Block 11 Dubai International Academic City Dubai U A E · T +971 4 279 1400 · F +971 4 279 1490

FB.com/BUiD.Team BUiD_Team youtube.com/BUiDadmin @BUiD_Team BUiD

Appendix 3: Approval Letter from the Department of Education and Knowledge

دائـرة الـتـعـلـيـم والـمـعـرفـة
DEPARTMENT OF EDUCATION
AND KNOWLEDGE

Date: 17th December 2019
Ref: G176

To: Public School Principal
To: Private School Principal

Subject: Letter of Permission

Dear Principals,

The Department of Education would like to express its gratitude for your generous efforts & sincere cooperation in serving our dear students.

You are kindly requested to allow the researcher/**Aishah Hassan Mohamed Ahmed Alyammahi**, to complete his research on:

How AI-Powered Online Education Drives and Improves Student Learning and Teacher Practice in Abu Dhabi Schools

Please indicate your approval of this permission by facilitating his meetings with the sample groups at your respected schools.

For further information: please contact **Mr Helmy Seada** on 02/6150140

Thank you for your cooperation.

Sincerely yours,

التاريخ: 17 ديسمبر 2019
الرقم: G176

السادة/ مديري المدارس الحكومية
السادة/ مديري المدارس الخاصة

الموضوع: تسهيل مهمة باحثين

تحية طيبة وبعد،،،

يطيبُ لدائرة التعليم والمعرفة أن يتوجه لكم بخالص الشكر والتقدير لجهودكم الكريمة والتعاون الصادق لخدمة أبنائنا الطلبة.

ونود إعلامكم بموافقة دائرة التعليم والمعرفة على موضوع الدراسة التي سيجريها الباحث/ **عائشة حسن محمد أحمد اليماحي**، بعنوان:

How AI-Powered Online Education Drives and Improves Student Learning and Teacher Practice in Abu Dhabi Schools

لذا، يرجى التكرم بتسهيل مهمة الباحث ومساعدته على إجراء الدراسة المشار إليها.

للاستفسار: يرجى الاتصال بالسيد/ **حلمي سعدة** على الهاتف 02/6150140

شاكرين لكم حسن تعاونكم

وتفضلوا بقبول فائق الاحترام والتقدير،،،

أ.د. مسعود عبد الله بدري
مدير وحدة البحوث والتخطيط وقياس الأداء

ص ب 36005 أبوظبي، الإمارات العربية المتحدة PO Box 36005 Abu Dhabi, United Arab Emirates |
T +971 (0)2 615 0000 F +971 (0)2 615 0602 E info@adec.ac.ae

Appendix 3: Teachers' Survey

Teachers' Survey

Teachers' Suvery

This survey aims to collect your feedback about the implementation of Alef Platform during the academic year 2019/2020. Any information about a participant's identity or school will be kept strictly confidential. Thank you for taking a moment to provide feedback that will help us to understand your perspective about implementing Alef Platform in your school with your students.

تهدف هذه الاستبانة إلى معرفة آرائكم وتقييمكم لتطبيق منصة ألف خلال العام الأكاديمي **2019/2020**. نؤكد لكم أن أية بيانات حول هوية المشاركين أو مدارسهم ستبقى خاصة وسرية. كما أننا نشكركم على مساهمتكم بالإجابة على أسئلتنا التي من شأنها أن تساعدنا على فهم تصوركم حول تطبيق منصة ألف في مدارسكم

*** 1. What do you do at school?**
ما هي وظيفتك في المدرسة؟

- **Teacher** - معلم
- **Principal** - مدير
- **Administrator** - إداري
- **Other (please specify)**
غير ذلك - يرجى تحديد الإجابة

*** 2. Your school region**
المنطقة التي تتواجد فيها المدرسة

- **Abu Dhabi** - أبوظبي
- **Al Ain** - العين
- **Al Dhafra** - الظفرة
- **Al Fujairah** - الفجيرة

* 3. Gender - الجنس

◯ Female - أنثى

◯ Male - ذكر

* 4. Age group - الفئة العمرية

◯ 25 - 30

◯ 31 - 40

◯ 41 - 50

◯ 51 - 60

◯ Above 61 - أكبر من 61 عام

* 5. Years of experience in the education sector
عدد سنوات الخبرة في قطاع التعليم

◯ 0-5

◯ 5-10

◯ 10-15

◯ 15-20

◯ 20-25

◯ Above 25 years - أكثر من 25 سنة خبرة

* 6. If you are a teacher, what subject do you teach?
إذا كنت معلمًا، ما هي المادة التي تعلمها؟

- Mathematics - الرياضيات
- Science - العلوم
- Arabic Language - اللغة العربية
- English Language - اللغة الإنجليزية
- Islamic Studies - الدراسات الإسلامية
- Social Studies - الدراسات الاجتماعية

* 7. Choose 1-5, with 5 being the highest and 1 is the lowest.
اختر من المقياس الآتي ما يُعبر عن رأيك بحيث يمثل الرقم 5 أعلى قيمة والرقم 1 أقل قيمة

	1	2	3	4	5
How do you rate your skills in using technology? ما هو تقييمك لمهاراتك في استخدام التكنولوجيا؟	○	○	○	○	○
How likely you are you to face challenges using technology? ما هو احتمال أن تواجه تحديات أثناء استخدام التكنولوجيا؟	○	○	○	○	○

	1	2	3	4	5
How do you rate the online and in-person professional development provided by Alef Education in terms of regularity? ما هو تقييمك للتطوير المهني الذي تقدمه شركة ألف للتعليم سواء عبر الإنترنت أو في المدارس من حيث الاستمرارية؟	○	○	○	○	○
How do you rate the online and in-person professional development provided by Alef Education in terms of quality? ما هو تقييمك للتطوير المهني الذي تقدمه شركة ألف للتعليم سواء عبر الإنترنت أو في المدارس من حيث الجودة؟	○	○	○	○	○

*** 8. To what extent do you Agree that Alef Platform...**
إلى أي مدى توافق على أن منصة ألف للتعليم...

	1	2	3	4	5
improves learning and teaching? - تساهم في تحسين التعلم والتعليم؟	○	○	○	○	○

	1	2	3	4	5
increases students' learning engagement? - تساهم في زيادة تفاعل الطلبة أثناء التعلم؟	◯	◯	◯	◯	◯
supports your students according to their needs? تقدم الدعم للطلبة بناءً على حاجاتهم؟	◯	◯	◯	◯	◯
increases students' motivation to learn? - تنمي حافز الطلبة للتعلم؟	◯	◯	◯	◯	◯
improves students' learning outcomes? - تحسن مخرجات التعلم لدى الطلبة؟	◯	◯	◯	◯	◯
helps students to discover new content and practice new skills? - تساعد الطالب على اكتشاف محتوى تعليمي جديد واكتساب مهارات جديدة؟	◯	◯	◯	◯	◯
helps enhance students' discipline and behavior problems? - تساعد في تحسين انضباط وسلوك الطلبة؟	◯	◯	◯	◯	◯

* 9. How do you rate the consistency of utilizing the below items on Alef Platform?
ما هو تقييمك للاستمرارية في استخدامك لمنصة ألف في البنود التالية؟

	1	2	3	4	5
Daily use of Alef Platform - الاستخدام اليومي للمنصة	◯	◯	◯	◯	◯
Checking students' performance data - الاطلاع على بيانات أداء الطلبة	◯	◯	◯	◯	◯
Monitoring students' performance during the class time - متابعة أداء الطلبة خلال الحصص الدراسية	◯	◯	◯	◯	◯
Reward stars to encourage students - منح الطلبة النجوم لتشجيعهم	◯	◯	◯	◯	◯

* 10. To what extent do the automated tools and ready resources available on Alef Platform save the time and effort spent on...
إلى أي مدى يساعد وجود المصادر التعليمية وأدوات التصحيح التلقائية على منصة ألف في التوفير من وقتك وجهدك المستغرق فيما يلي

	1	2	3	4	5
creating formative and summative assessments? - إعداد أسئلة التقويم التكويني والختامي؟	◯	◯	◯	◯	◯
grading formative and summative assessments? - تصحيح أسئلة التقويم التكويني والختامي؟	◯	◯	◯	◯	◯
preparing and producing teaching resources? - تحضير وإنتاج المصادر التعليمية؟	◯	◯	◯	◯	◯
instructing the students? - الشرح والتلقين خلال الحصة؟	◯	◯	◯	◯	◯
maintaining students' record and progress reports - الاحتفاظ التلقائي بسجلات الطلبة وتقارير تطورهم	◯	◯	◯	◯	◯

* 11. To what extent do you agree that...
إلى أي مدى توافق على أن...

	1	2	3	4	5
implementing the Alef platform shifted your role from an instructor to a facilitator or coach? - تطبيق منصة ألف ساهم في تحويل دورك من معلم إلى مدرب أو مدير للحصص الدراسية؟	○	○	○	○	○
Alef Platform supports you when it tracks each student's progress during their learning journey? منصة ألف تساعدك في متابعة أداء الطلبة أثناء تعلمهم على المنصة؟	○	○	○	○	○
Alef Platform helps you improve classroom management? - منصة ألف تساعدك في تحسين إدارة الصف؟	○	○	○	○	○
Alef Platform supports you during remote learning amidst Covid-19? - منصة ألف قدمت الدعم لك خلال فترة التعلم عن بعد في ظل انتشار كوفيد-19؟	○	○	○	○	○

	1	2	3	4	5
you are happy using Alef Platform? - راض عن استخدامك لمنصة ألف؟	◯	◯	◯	◯	◯

* **12. Did you face any challenges while using Alef Platform?**
هل واجهتك أي تحديات خلال استخدامك لمنصة ألف؟

* **13. How is Alef Platform supporting you during Covid-19? -** كيف قدمت لك منصة ألف الدعم في ظل انتشار كوفيد-19؟

* **14. General comments: Please provide any other feedback or comments you would like to share related to your experience using Alef Platform.**
ملاحظات عامة: يرجى تزويدنا بأي تغذية راجعة أو ملاحظات تتعلق بتجربتك في استخدام منصة ألف