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Optimising adaptive learning: A case study of Intelligent Tutoring Systems in schools in Qatar, using the Activity-Oriented Design Method

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Abstract

Artificial Intelligence (AI) tools such as Intelligent Tutoring Systems (ITSs) are claimed to be revolutionising the field of education, transforming the way we teach and the way we learn. Consequently, it is imperative to assess how these technological tools can be optimised, to draw upon their advantages and mitigate potential drawbacks. This paper investigates the attitudes and perceptions of educators towards the integration of AI-powered ITSs. The study examines an educational activity which utilises an ITS, in selected International Baccalaureate schools in Qatar, examining perceptions of teachers through Activity Theory and the Activity-Oriented Design Method (AODM). The paper reviews literature using Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA), then presents a case study which deployed online surveys to collect data. While the findings show that teachers hold favourable views and positive attitudes towards the integration of this ITS into the activity, they have uncertainties about the ethical implications of integrating such AI tools. The study offers insights into the perceptions of teachers in Qatar towards the utilisation of ITSs, focusing on the societal motives and demands. Further research opportunities are discussed, through which to better explore the application of Activity Theory for studying AI in educational contexts.

1. Introduction

In recent years, the field of Artificial Intelligence (AI) has emerged as a prominent catalyst for transformation across various sectors including education. Due to its wide-ranging applicability and ease of integration, AI has impacted the educational landscape and has influenced educational priorities and trends. The global landscape of education is changing, with unprecedented demands to integrate AI-powered technologies in learning and teaching. Over the past decades, education in K-12 has witnessed the involvement of digital technologies in classrooms and beyond. AI has gained great attention in education, offering a wide range of tools and applications such as chatbots, adaptive testing, predictive analytics, and Intelligent Tutoring Systems (ITSs) (Wang et al., 2023). AI-powered tools can be classified as AI-powered tools for *teaching* and AI-powered tools for *learning*, with the reality of educational settings meaning that these tools are intertwined. In this paper, AI-powered tools for teaching, particularly ITSs, are explored to gain insights into their effectiveness in providing adaptive learning experiences.

The use of AI in education has attracted attention in many ways, due to its unique features. Firstly, automation; perhaps the most important feature that AI tools provide is the automation of tasks that are normally performed by humans, such as grading, classifying data, evaluating, and scheduling (Joshi et al., 2021). Secondly, integration; AI tools often enable solutions that can be embedded in other IT initiatives and tools. Thirdly, identification; through collecting, and analysing data, AI tools provide adaptive solutions that can assist teachers to address students' needs and support their learning. Zawacki-Richter et al. (2019) indicate that AI in Education (AIED) applications offer significant support in academic services in main four categories: profiling and prediction; assessment and evaluation; adaptive systems and personalisation; and finally, ITSs.

The number of AI applications in education has increased significantly in recent years. According to the Horizon Report (Pelletier, 2021), AI applications are predicted to grow significantly in higher education and consequently in other levels of education. The education sector has witnessed the utilisation of numerous AI applications, which have been extensively examined in prior scholarly literature. For instance, Wang et al. (2023) discusses the integration of ACTIVE Math, MATHia and Why2Atlas to provide interactive learning environments in higher education settings. Other examples include AI-powered applications used in multidis-

ciplinary contexts such as Grammarly, Ecree and PaperRater offering a range of benefits from writing improvements and grading to plagiarism detection (Wang et al., 2023). These AI applications are merely selected examples from a huge range of available digital tools, with new ones enrolled daily, illustrating the growth of spending on AI applications by technology giants such as Google, Amazon and Microsoft, developing AI solutions and acquiring AI startups to meet increasing demand (Zawacki-Richter et al. 2019).

Research in previous years has increased due to the need to evaluate the effectiveness of such technological applications. As the integration of AI in education claims to revolutionise social interaction in every aspect, innovative approaches to teaching and learning are being developed and evaluated (Tominc & Rožman, 2023). In line with this integration, AI-powered tools, particularly ITSs, are reshaping how educational activities are mediated. The learning models of students, and teaching models of teachers, have undergone significant changes in recent years as a result of the integration of these digital technologies in classrooms (Joshi et al., 2021). In addition, instructional approaches have been modified to meet the growing demands associated with this technological integration. In this paper, digitally mediated teaching is explored, as teachers integrate ITSs to mediate their activity, seeking to provide adaptive learning experiences and ultimately improve students' outcomes. The study aims to explore the integration of an ITS into such teaching. The paper describes the application of Mwanza's (2002) Activity-Oriented Design Method (AODM) to analyse this ITS-mediated activity. The paper addresses the following research questions:

- *RQ1*: How do teachers incorporate the use of an ITS to provide personalised and adaptive learning experiences in their practices?
- *RQ2*: To what extent are student data being used to support adaptive and personalised learning experiences? What are the ethical implications?

This research endeavours to examine the effectiveness of AI applications in selected International Baccalaureate schools in Qatar, focusing on how technologies interact with societal motives and broader educational goals. The societal motives for integrating AI in education reflect growing demands for further exploration of the interactions that coexist in a technology-mediated activities, such as teaching and learning interactions. This integration of AI raises critical concerns about how educational technology mediates the relationship between policy imperatives and practical realities in the classroom.

The study set out below explores perceptions of teachers in integrating an ITS into their teaching practices to support students, to address the benefits of providing personalised learning experiences and to improve students' outcomes. Moreover, the study examines ethical considerations of the use of AI powered tools, exploring the constraints and considerations pertaining to privacy. The paper uses Mwanza-Simwami's (2011) AODM to address a significant research gap in AI research in education, particularly regarding teachers' perceptions and ITS applications in K-12 settings. Consequently, the findings will potentially inform the decision-making process within school settings, to better understand the effective integration of ITSs in their systems. Additionally, the findings will contribute to AI literature by providing insights on evaluating technology as a mediating tool, to improve teaching and learning, highlighting the ethical implications.

This paper commences with a brief literature review of prior related work undertaken in the domain of AI in education. The theoretical framework is then discussed, followed by the methodology. The findings section follows, where the results are shared, speculating on the implications in the discussion section. Finally, the conclusion sheds light on limitations and further recommendations.

2. Literature review

This section explores research trends in AIED applications, through an inductive review of related literature using the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) (Page et al., 2021; Moher et al., 2009). The review followed a three-phased process: 1) searching the databases to identify related literature, 2) screening the identified literature using inclusion and exclusion criteria, 3) assessing identified papers for eligibility and finally 4) including selected articles and composing a comprehensive report.

The main themes that have been categorised from reviewing previous literature are adaptive learning using AI solutions such as ITSs, and the potential and challenges of integrating AI in educational settings.

2.1 Adaptive learning using AI solutions

Many researchers believe that future applications of AI hold great potential in education. Joshi et al. (2021) argue that if AI models are tackled closer to human thinking and continuously evaluated, then they will positively impact the improvement of education in various aspects such as

personalisation of learning. This reflects increased attention towards providing adaptive learning experiences. Adaptive learning refers to the modification of curriculum activities, the level of difficulty and the interface, reacting to the individual needs of a student or a group of students (Joshi et al. 2021). It is argued that adaptive learning can have a long-term effect on students, enabling teachers to better understand the students' needs, and further supporting academic success (Vincent-Ruz & Boase. 2022).

Wang et al. (2023) explore the potential impact of AI on international students in higher education where adaptive technologies such as adaptive testing, chatbots and ITSs offer positive outcomes for non-native speakers of English in Western higher education institutions, to find that the potential benefits that AI offers for adaptive learning have become a critical tool. Vincent-Ruz and Boase (2022) investigate the effectiveness of ITSs as an adaptive learning technology, to support chemistry education, and to engage students in personalised experiences. They find that ITSs offer unique individualised learning paths to support students.

The integration of AI in education is researched in various educational settings and socioeconomic contexts. Research by Wang et al. (2023) conducts a comparative study of an adaptive learning system called Squirrel AI Learning, with teacher-led instruction in China, examining the efficiency of adaptive technology which utilises AI and machine learning. Whilst their study concludes that Squirrel AI Learning offered significant benefits to support students in Chinese educational settings, the role of humans as mediators is critical, with further research needed to better support the selection and use of such adaptive technologies compared to traditional instruction led by a teacher.

Gamified ITSs have been also researched in different socio-economic contexts, for instance Joaquim et al.'s (2021) study in elementary schools for low-income students in Brazil. Their study concludes that the potential of ITSs to provide students with adaptive learning experiences is significant, and thus it is important to align a gamified ITS with the relevant curriculum and pedagogies.

A study by Tominc and Rožman (2023) examines the perceptions of undergraduate and postgraduate students in higher education in the field of business and economic studies. They find significant differences in how students of various levels perceive the importance of AI (Tominc & Rožman, 2023). The authors also emphasise the need for active development and integration of AI in education, highlighting the ethical considerations associated with the use of such tools.

2.2 Potential and challenges of integrating AIEd

Kamruzzaman et al. (2023) explore the integration of AI and IoT in sustainable education systems during the pandemic of COVID-19. Their research discusses the opportunities that AI chatbots and Internet of Things sensors in have to offer ITSs. The authors claim that the integration of such tools can revolutionise the educational landscape offering personalised learning, tailored content, adaptive assessments, and feedback (Kamruzzaman et al., 2023). This potential benefit is also supported by previous studies that highlight the use of data-driven personalised learning paths. Singh et al. (2022) offer a custom-tailored ITS called SeisTutor aimed to provide personalised and quality education through the implementation of cognitive intelligence. SeisTutor utilises natural-inspired algorithms to understand learners' progress and behaviours, to recommend custom-tailored learning paths.

Such works indicate that the potential of ITSs has expanded over the past years. Another study that emphasises the integration of AIEd through deliberate evaluation of the ITS is Joshi et al.'s (2021) examination of the perceptions of teachers and students regarding the use and effectiveness of AI. They conclude that while evolving AI solutions offer significant potential, the continuous need to evaluate these technologies should recognise ethical considerations.

In language learning, Yu and Nazir (2021) highlight the use of AI-based systems to revolutionise teaching and learning methods, with chatbots and ITSs for English learners offering significant potential to learners of a second language. Yu and Nazir (2021) emphasise that such AI-powered tools should be researched in other subjects and disciplines, to enhance learning and teaching experiences.

Amanda et al. (2021) explore the top-down implementation of an ITS, for teaching mathematics to first-grade primary school students in Indonesia. Their study describes how the ITS incorporates an adaptive approach, to dynamically adjust the difficulty level and pace of instruction. The study concludes that collaboration is needed, between teachers, to gather feedback and insights on the usability and effectiveness of the ITS, refining and improving the systems to better meet the needs of students and teachers.

AI solutions continue to advance, driving research to address the risks and limitations of AI in education. Kamruzzaman et al. (2023) urge ethical and responsible uses of AI in education to ensure equal access for all students. While adaptive learning technologies such as ITSs, chatbots and other AI solutions provide significant benefits and advance-

ments in supporting personalised learning, calls to consider the ethical implications are raised in numerous studies. Enhancing transparency and fairness in ITS algorithms enables students and educators alike to better understand how these systems work, and how decisions and recommendations are made (Vincent-Ruz & Boase, 2022).

Overall, the literature provides valuable insights into the potential benefits and challenges of integrating AI in educational settings. The need to explore the attitudes and perceptions of teachers is also valuable, to better understand the adoption and usage motives. Few studies undertake research from a sociocultural perspective such as Activity Theory. While recent literature comprehensively examines the research trends of AI applications in education, most recent studies overlook the perceptions of people directly involved, whose activities are mediated by AI-powered tools. Moreover, although previous research explores ethical concerns of AI in different educational settings, still there is a need to investigate the understanding of teachers towards the ethical concerns, expanding their awareness of these issues when using AI in their classrooms.

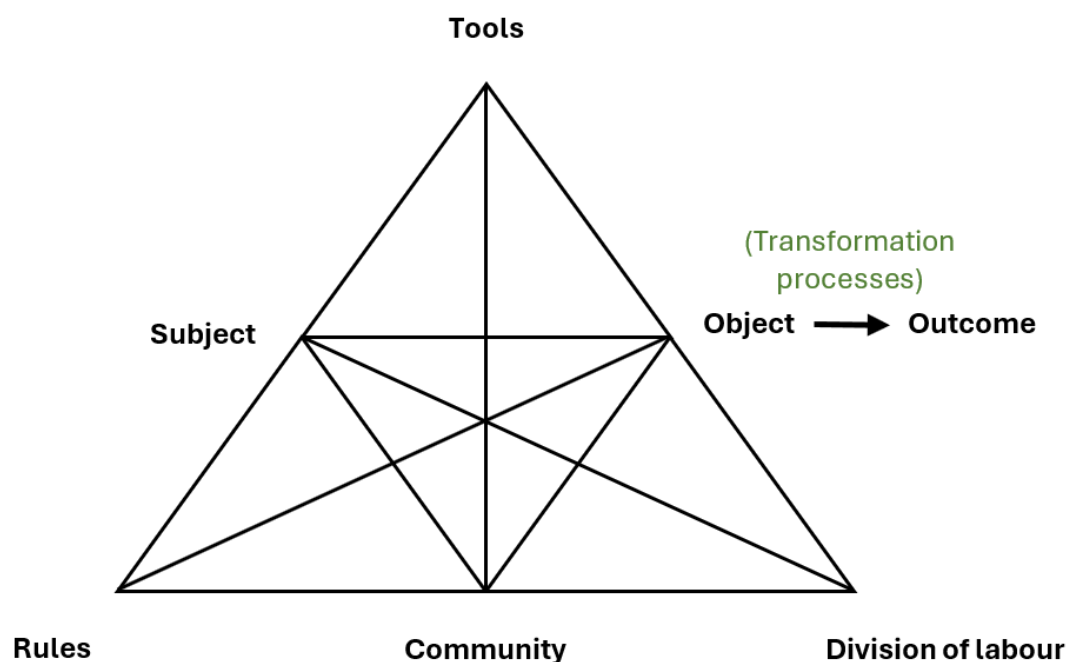
Therefore, this paper endeavours to investigate the activity of using ITS in selected schools in Qatar, examining the perceptions of teachers towards integration, while highlighting associated ethical concerns such as privacy, fairness, and trustworthiness.

3. Theoretical framework

Prior to exploring the theoretical framework that constitutes the basis of this research, it is essential to clarify the author's ontological and epistemological stances, as these impact the selection of theory and research methodology. I adopt an interpretive ontology, acknowledging that reality is subjective and shaped by the unique and shared experiences of individuals (Pring, 2015). My perspective on knowledge aligns with social constructivism, which posits knowledge as a product of collaborative interactions within particular social contexts (Bower, 2019). In order to gain a comprehensive understanding of the perceptions of teachers towards how an ITS supports their practices in providing adaptive learning—while highlighting the ethical issues associated with this use in K-12 educational settings—I use a lens of Activity Theory.

Activity Theory has its roots in the sociocultural and sociohistorical theories developed by Vygotsky (1978) and Leont'ev (1978) drawing on sociocultural and historical theories that emphasise the importance of learning within

Figure 1. Activity triangle model, also known as an activity system (adapted from Engeström, 2001).



specific contexts and relationships, rather than learning residing solely within the individual's mind. Learning is thus argued to be a result of active engagement in collaborative activities, deeply intertwined with social practices and facilitated using artefacts (Greenhow & Belbas, 2007). In recent years, there has been a surge of scholarly attention towards researching the concept of communities and the development of social groups, which promote both individual and collective progress.

Building upon Vygotsky's (1978) theoretical framework about mediated action (Rieber, 1997), Leont'ev (1981) formulated the widely recognised three-level model of activity. The object or "motive" is proposed by as the fundamental element that drives human activity at its core. Additional analytic methods for modelling activity systems have been contributed by more recent discoveries in Activity Theory, such as Engeström's (2001) seminal work. Engeström's expanded Activity Theory has been a focal point of significant recent advancements (Cong-Lem, 2022). The provided definition of activity systems has been described as an object-oriented, collective, and culturally mediated human activity. Additionally, Engeström (2001) introduced the expanded triangle (Figure 1) as a visual representation of the constituent elements inside an activity system. The parts encompassed in this framework consist of the subject, object, community, and various mediators of human activity, such as tools, rules, and division of labour (Engeström, 2001).

The AODM proposed by Mwanza (2001) follows an iterative approach to analyse and characterise the practices of subjects, as they use certain tools to achieve a certain shared object. This design method takes into consideration the motives of the subjects as well as the social and cultural factors involved within the context of the activity. The AODM toolkit is presented to 1) provide an application of the fundamental principles of Activity Theory, 2) offer methodological tools to identify essential elements of human activity, and 3) support researchers in identifying contradictions that may occur in an activity being analysed (Mwanza-Simwami, 2011).

4. Research design

4.1 Methodology

This study is a qualitative case study supported by quasi-statistical data, to explore the perceptions of teachers in selected schools in Qatar towards the integration of ITSs in their teaching and its potential impact on supporting adaptive learning experiences. The choice of this research design is consistent with our ontological outlook and epistemological perspectives highlighting the significance of interpretive and constructivist paradigms. Adding to that, the selected methodology approach enables for in-depth analysis of the phenomenon being explored within its social

and cultural contexts. This study employed the AODM toolkit developed by Mwanza-Simwami (2011) to provide an understanding of the activity system being analysed. The AODM presents advantages for examining instructional methods, assisting the instructional design in a particular community by enabling the process of drawing connections and reinforcement of sub-activities for a common objective (Greenhow & Belbas, 2007).

There are four methodological tools incorporated in AODM. The first methodological tool is the Eight-Steps Model as proposed by Mwanza-Simwami (2011). This tool facilitates the application of the fundamental principles of Activity Theory, by translating its components into elements that are relevant to the activity being investigated. For this paper, the Eight-Steps Model (Table 1) was used to help in

identifying the principles of the activity being examined; the integration of an ITS in selected schools, to assess and evaluate the adaptive learning outcomes.

The second methodological tool is the activity notation. Activity notation is also used to highlight relationships, especially in this current paper the relationships between the subject (teachers)-tool (ITS)-object (adaptive learning), to reduce the complexity in the analysis.

The third methodological tool is the AODM's techniques of generating general research questions. These assist with focusing on investigating teachers' implementation of an ITS into their teaching practice, exploring their perceptions towards this implementation to enable adaptive learning for students (Table 2).

Table 1. The Eight-Steps Model adapted from Mwanza-Simwami (2011).

Identify the:		Questions to ask:
Step 1	Activity of Interest	What comprises the incorporation and utilisation of an ITS in these selected schools?
Step 2	Objective	How do teachers use an ITS to support their adaptive/personalised teaching practices?
Step 3	Subjects	Who are the teachers (Math and English)?
Step 4	Tools	How do ITSs mediate, namely: IXL, a personalised learning platform for math and literacy (https://www.ixl.com/); and Measures of Academic Progress (MAP) Growth, a personalised platform to assess students skills in literacy and math (https://www.nwea.org/map-growth/)?
Step 5	Rules & Regulations	How is activity influenced by school policy, communication letters, announcements, school cultural norms?
Step 6	Division of Labour	How are tasks allocated amongst students, Primary Years Programme coordinators, Middle Years Programme coordinators, Vice Principals, Principals, Directors?
Step 7	Community	How is the activity influenced by Academic/ administration staff/ tech support team/ Programme coordinators, Vice Principals, Principals, Directors, and parents?
Step 8	Outcome	How is the object of the activity connected to wider social circumstances?

Table 2. Techniques of Generating General Research Questions, adapted from Mwanza-Simwami (2011).

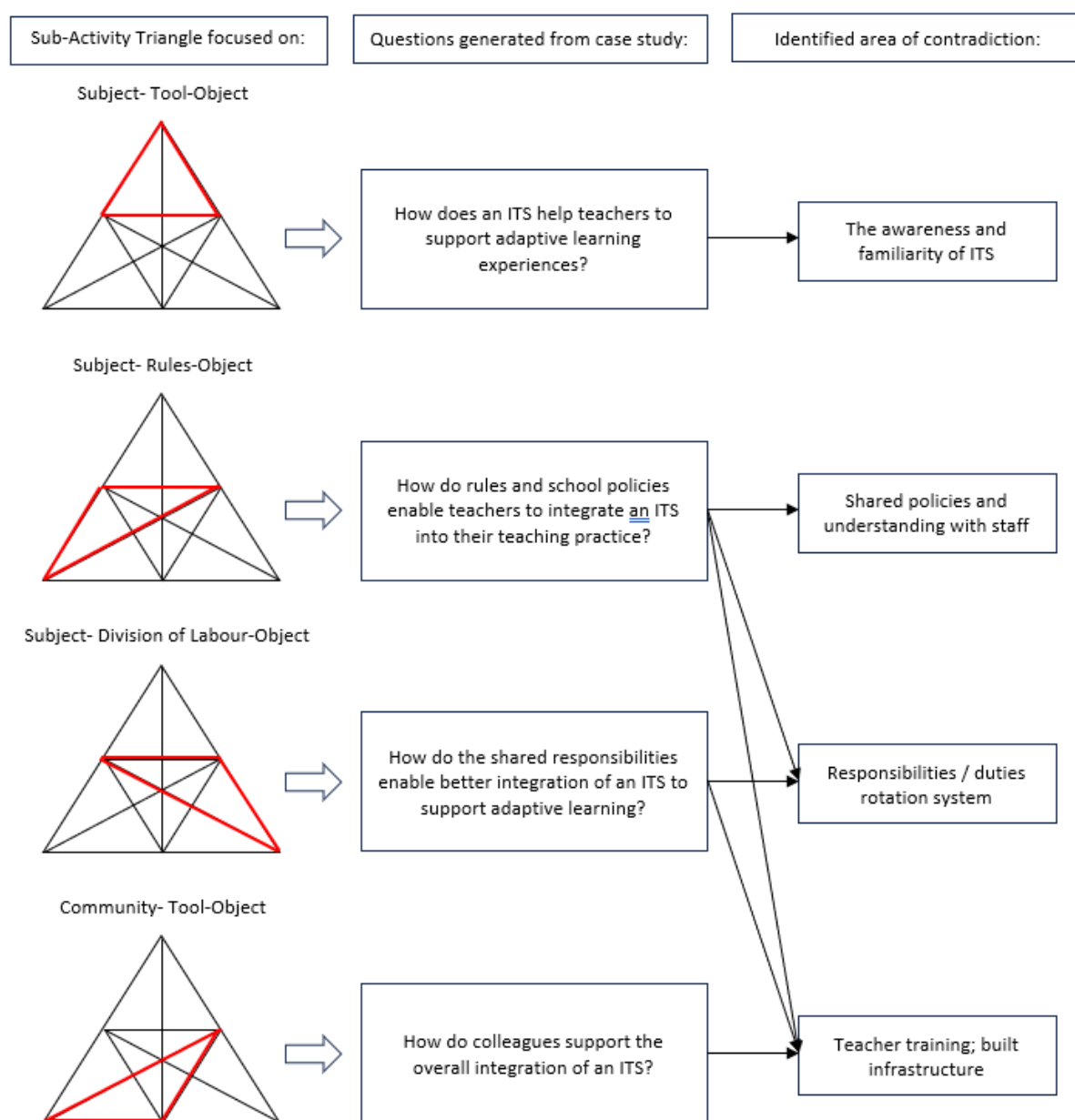
Technique of Generating General Research Questions
1) What AI/ITS tools do teachers use to achieve adaptive learning experiences? 2) What rules/policies affect the way teachers integrate an ITS to achieve enabling adaptive learning? 3) How does the division of labour influence the way teachers satisfy their motives to enable adaptive learning experiences? 4) How does the ITS used affect the way the community satisfies their motives? 5) What Rules/policies affect the way the community satisfies their objectives? 6) How does the division of labour affect the way the community achieve their objectives?

Lastly, the fourth methodological tool is mapping the operational processes, to identify nodes of interactions within the system as well as the contradictions that occur (see Figure 2).

Mwanza-Simwami (2011) attempted to evaluate the use of AODM as an underpinning theoretical framework, through the analysis of previous studies of Greenhow and Belbas (2007) and Dolonen and Dolonen (2009). Both studies had used AODM to evaluate design processes, highlighting the relationships and contradictions. For instance,

Greenhow and Belbas (2007) used AODM to develop a comprehensive understanding of collaborative knowledge building. Dolonen and Dolonen (2009), however, used AODM to investigate roles of teachers and students in the design of innovative educational software. According to Mwanza-Simwami (2011), in both studies, AODM offered a great contribution to support researchers in numerous ways such as generating research questions highlighting the relationships and contradictions that exist in an activity. Additionally, AODM provides a detailed descriptive analysis of an activity being investigated.

Figure 2. AODM's techniques of mapping operational processes, from Mwanza-Simwami (2011).



AODM is used in this study to create a comprehensive understanding of the perceptions of teachers who utilise AI in their teaching practices, to provide adaptive learning experiences. While many studies encourage the use of AODM in the initial design processes of instructional design, it can offer insights to educational researchers at subsequent developmental stages such as the incorporation of emerging technologies into an existing activity (Greenhow & Belbas, 2007). This aligns with the finding in this research, that the Eight-Steps Model increases understanding of the nodes in activity, the relationships, and the contradictions.

4.2 Method

Two methods of recruiting participants were used, random sampling to recruit teachers working in International Baccalaureate schools in Qatar, and focus group sampling to recruit participants in private schools who were anticipated to have a moderate knowledge of ITSs such as IXL, MyiMath and MAP Growth, and who were incorporating these tools in their instructional practices. The rationale was that these schools have a degree of flexibility and resource, to adapt and implement multiple online resources including ITSs in their instructional systems; in contrast, public schools are constrained by limited numbers of technological tools, mandated by the Ministry of Education and Higher Education (MoEHE).

Online Surveys were distributed via email to 12 International Baccalaureate schools in Qatar, and concurrently shared on LinkedIn to random samples of participants from mid-October to November 2023. The items of the survey were constructed using The Eight-Steps Model (Mwanza, 2002) guided by Activity Theory as an underpinning theoretical framework to gain insights about the perceptions of teachers towards the integration of an ITS to support adaptive learning. Additionally, items related to the ethical implications of AI were adapted from relevant scholarship (e.g. Hunkenschroer & Luetge, 2022; Prem, 2023).

The online survey consisted of 26 statements, addressing the fundamental principles of Activity Theory. Participants were asked to rate their agreement on a 5-point Likert-type scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Ethics, study purpose and informed consent were shared with participants before collecting data. All responses were voluntary and completely anonymous, and no personal data were collected. The number of responses to the surveys was limited to seven.

5. Findings

In this section, the results of the seven online surveys are discussed. 71 per cent (n=5) were teachers, and 29 per cent (n=2) were coordinators. 14 per cent (n=1) of the participants have 1-5 years of experience, 43 per cent (n=3) have 6-10 years of experience and 43 per cent (n=3) have over 10 years of experience. The results are organised as follows:

5.1 Tools of the activity

The online survey items shown in Figure 3 relate to tools (ITSs) mediating their pursuit of the objective (adaptive learning). 29 per cent (n=2) of participants responded that they use an ITS to support their roles in providing personalised learning experiences, whereas 57 per cent (n=4) they responded that they do not use an ITS in their practice. 43 per cent (n=3) of participants believe that they are aware of the efficiency of an ITS in providing adaptive learning experiences, whereas 43 per cent (n=3) believe that they are not aware of an ITS having potential impact on adaptive learning. Responding to whether participants are familiar with the ITS and AI tools their schools offer, by having subscriptions to those AI solutions, 43 per cent (n=3) responded affirmatively, whereas 29 per cent (n=2) believed that they were not familiar with an ITS being provided in their schools. Regarding the statement of the participant's ability to align the potential of ITSs with the educational goals of the grade they teach, and with the overall educational goals of their school, 43 per cent (n=3) agreed to that statement, whereas 43 per cent (n=3) disagreed.

5.2 Rules of the activity

The online survey items in Figure 4 refer to how teachers/ coordinators/ educators perceived the rules and policies concerning ITS usage in their schools. 43 per cent (n=3) agreed that they were aware of the school's policies regarding the integration of technology (including an ITS) in their schools, whereas 34 per cent (n=3) were neutral, and only 14 per cent (n=1) believed that they were unaware of such policies in their settings. 57 per cent (n=4) of participants believed that they could suggest AI-powered tools that could further support teaching and learning in their schools whereas 29 per cent (n=2) were neutral and only 19 per cent (n=1) believed that they did not have this ability.

Figure 3. Survey items for the perceptions of teachers towards the tools of the activity. X-axis shows per cent of the group (n=7).

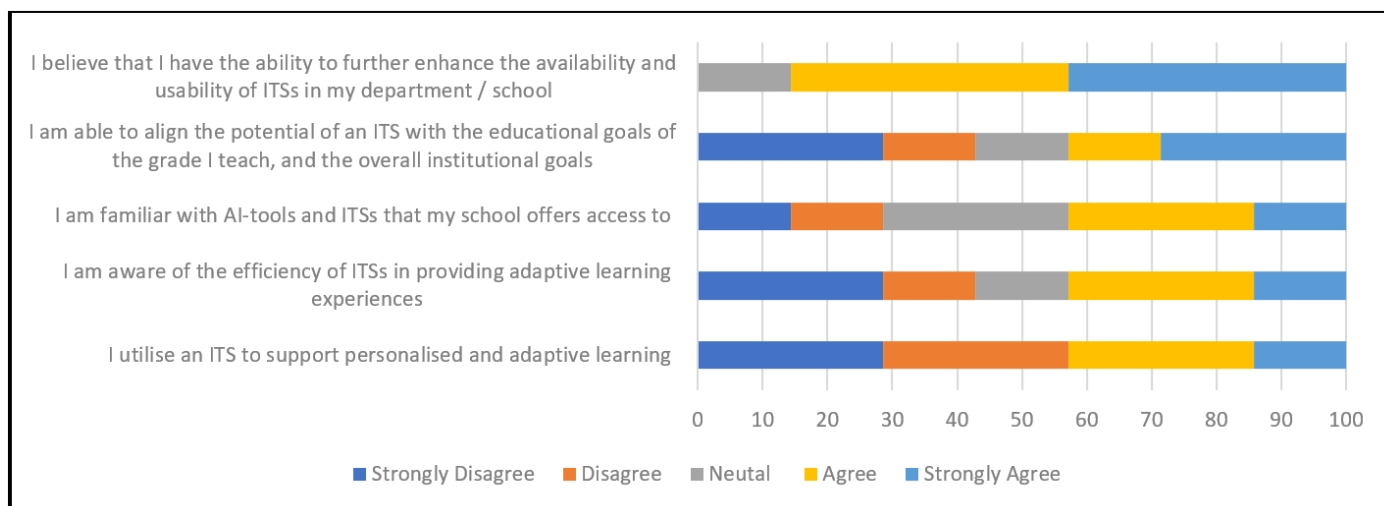
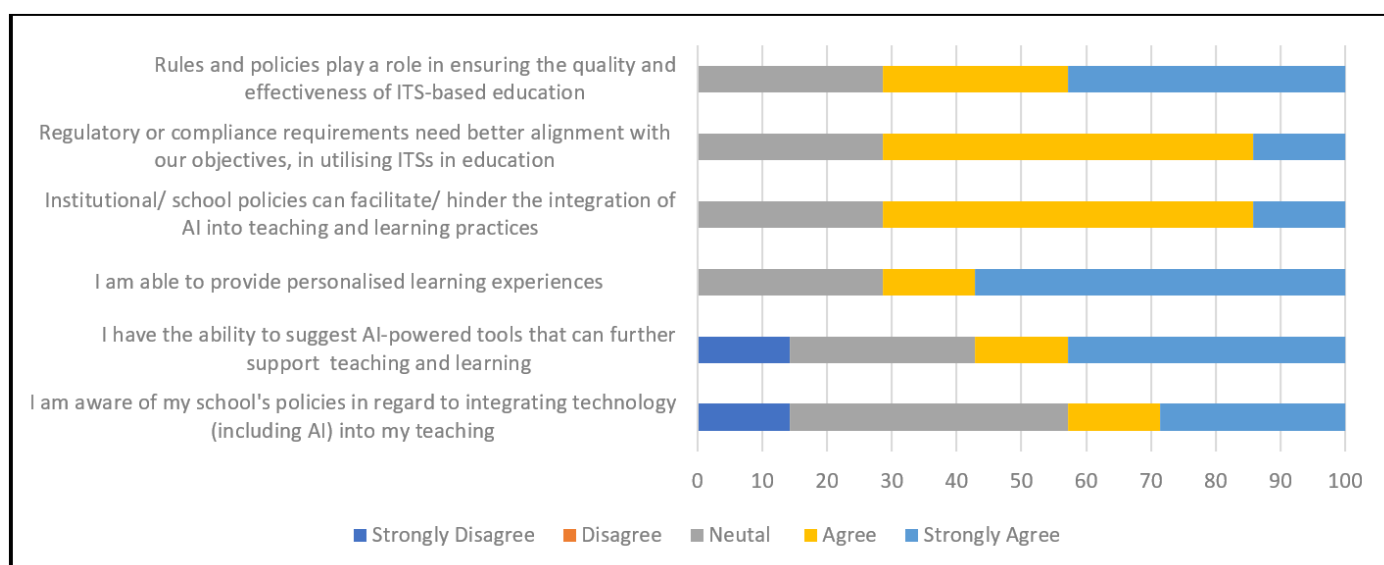


Figure 4. Survey items for the perceptions of teachers towards the rules of the activity. X-axis shows per cent of the group (n=7).



Similarly, 71 per cent (n=5) believed that institutional/ school policies facilitated/ hindered the integration of AI in teaching and learning practices. 71 per cent (n=5) believed that regulatory or compliance requirements needed better alignment with the school objectives, in regard to the utilisation of ITSs in their practice. Lastly, 71 per cent (n=5) believed that rules and policies played a role in ensuring the quality and effectiveness of an ITS, and thus needed refinement to better serve the overall goals and objectives of the school.

5.3 Division of labour of the activity

In Figure 5 below, the surveys items indicate how participants perceived the relationship between the division of labour and the utilisation of an ITS to achieve the objective, to support adaptive learning. 86 per cent (n=6) believed that the distribution of responsibilities among teachers, administrators and students affected the successful integration of an ITS in their schools. Similarly, 86 per cent (n=6) also believed that collaborative efforts and shared responsibilities

Figure 5. The perceptions of teachers towards the division of labour of the activity. X-axis shows per cent of the group (n=7).

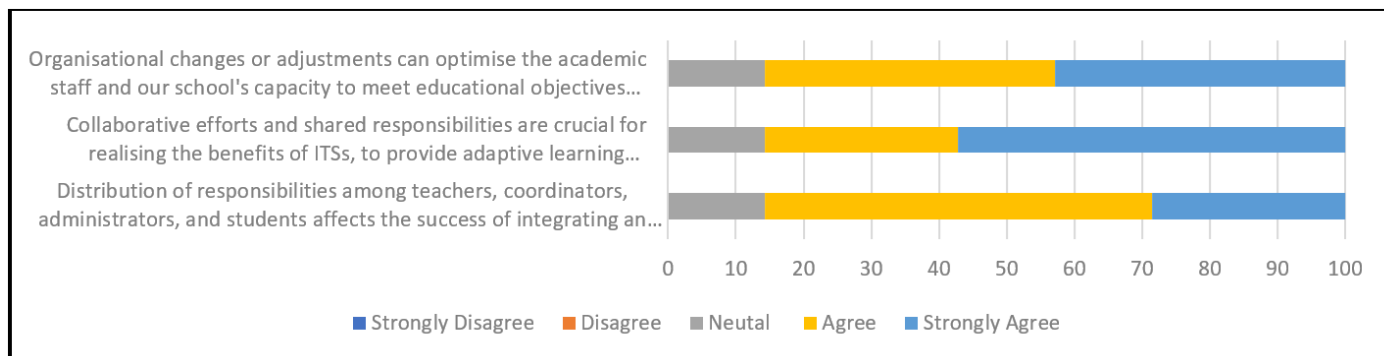
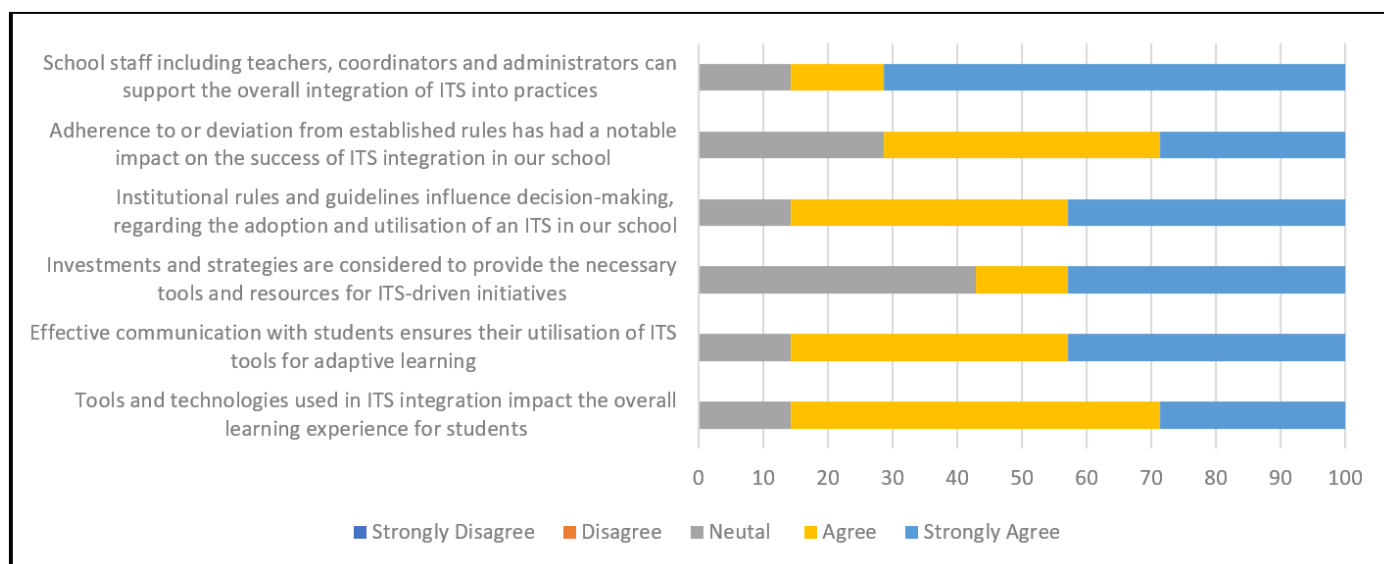


Figure 6. Teachers' perceptions towards the community of the activity. X-axis shows per cent of the group (n=7).



were crucial for realising the benefits of an ITS, to offer adaptive learning experiences. Furthermore, 86 per cent (n=6) believed that organisational changes could optimise capacity, to meet educational objectives through the adoption of an ITS.

5.4 Community of the activity

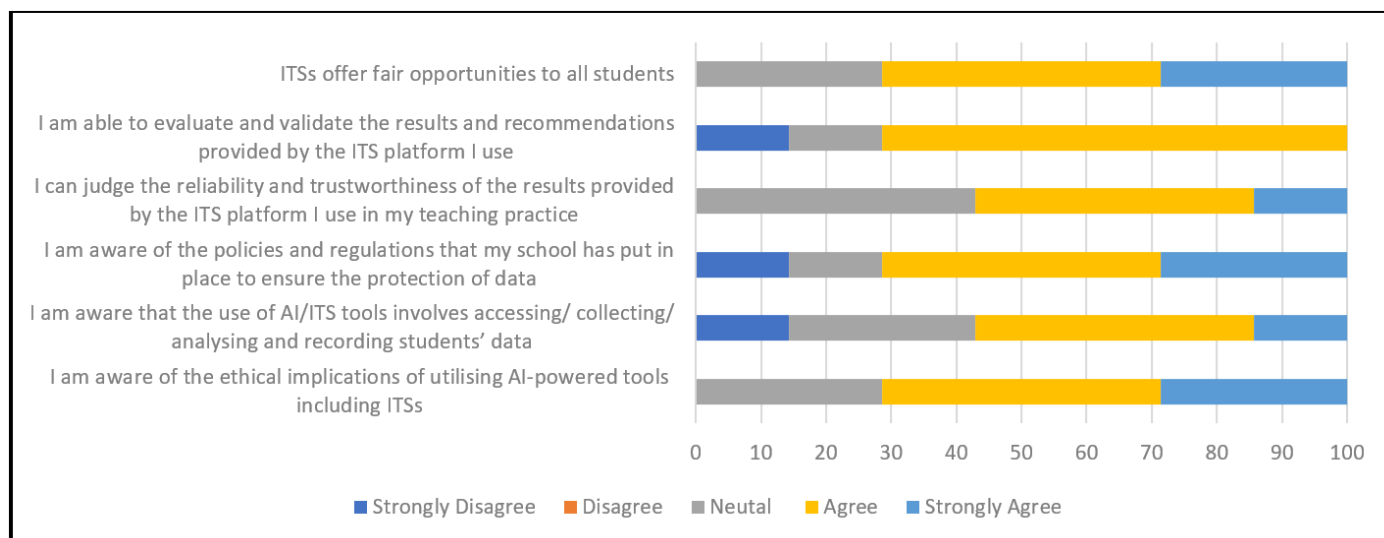
The survey's items in Figure 6 reflect participants' views about the relationship between the community, and the integration of an ITS, to achieve the objectives. 86 per cent (n=6) believed that factors such as infrastructure and staff training impacted the utilisation of an ITS to support the overall learning experiences for students. Furthermore, 86 per cent (n=6) also believed that effective communication with students, to ensure effective utilisation of an ITS, contributed to the broader educational community. 86 per

cent (n=6) of participants believed that the school community including teachers, coordinators, teachers' assistants, administrators, and leadership teams could support the overall integration of an ITS in their schools.

5.5 Ethics for using an ITS

Finally, the survey items shown in Figure 7 reflect the views of participants on ethics, and how they perceived ethical considerations for using an ITS. Regarding participants, awareness of the ethical implications of utilising AI-powered tools such as an ITS, 71 per cent (n=5) believed that they were aware of such implications. Additionally, 71 per cent (n=5) believed that they were aware of the school's internal policies, to ensure the ethical use of such AI tools. However, 57 per cent (n=4) believed that they could judge the reliability and trustworthiness of the results provided by

Figure 7. Teachers' perceptions and awareness towards the ethical concerns of utilising an ITS. X-axis shows per cent of the group (n=7).



the ITS platform they used in their teaching. Regarding the fairness of ITSs, 71 per cent (n=5) believed that ITSs offered fair opportunities to all students, and consequently that an ITS could provide individualised learning experiences. Adding to that, 71 per cent (n=5) believed that they could evaluate and validate the results and recommendations provided by the ITS, based on their professional experiences.

6. Discussion

In this section, findings are discussed in relation to the research questions, using Activity Theoretical principles and the AODM to better understand the relationships, and secondary contradictions, that manifest in the activity system informing this research. The elements of activity, and selected secondary contradictions between them, are illustrated in Figure 8 and discussed below using the structure of the research questions which opened the paper.

6.1 RQ1: How do teachers incorporate the use of an ITS to provide personalised and adaptive learning experiences in their practices?

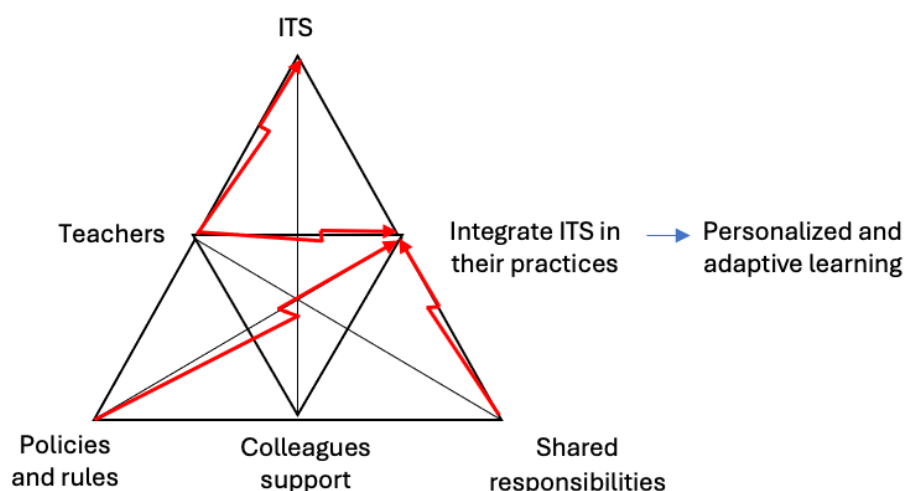
Based on the findings, most teachers and coordinators believe that the integration of an ITS in their teaching practice supports the personalisation of learning and offers adaptive learning experiences. Although some indicated that they were not aware of an ITS or AI-powered tools used in their school ecosystem, they believed that offering such an opportunity to students would enable them to

better understand the academic strengths and weaknesses of their students—thus offering data-driven action plans and support. Additionally, most teachers believed that an ITS could offer personalised learning experiences; they were aware of the benefits of individualisation of learning, to better meet all students' abilities and cognitive skills. This finding is consistent with previous studies, which illustrate significant benefits of AI for learning experiences (Joaquim et al., 2022; Wang et al., 2023). Teachers indicated that they could align the utilisation of an ITS in their roles with the overall educational goals and outcomes. They believed that the rules and regulations within their schools could facilitate or hinder the utilisation of an ITS. Regarding the division of labour, teachers believed that shared responsibilities—to enhance the integration of an ITS—were essential to gain insights into how to support an adaptive learning approach. Teachers viewed the community of their schools, and the cultural and social norms, as impacting on the utilisation of an ITS in their practice. In addition, teachers believed that collaboration and effective communication influenced the effective adaptation of an ITS to mediate their teaching and learning activity.

6.2 RQ2: To what extent are student data being used to support adaptive and personalised learning experiences? What are the ethical implications?

The findings show that teachers were aware of the ethical implications of AI-powered tools including ITSs. Most teachers realised that using AI-powered tools involved gathering, accessing, analysing, retrieving, and storing students'

Figure 8. Secondary contradictions of the teachers' activity system.



data. This realisation indicates that teachers were aware of the potential risks involved, especially data privacy, fairness, and trustworthiness. Although some teachers acknowledged that it is sometimes difficult to judge the results and recommendations provided by an ITS, they might be able to judge those results through the lens of their own professional experiences and expertise as teachers. Another issue raised was that relying upon an ITS to provide personalised learning may impact the academic integrity of students, a finding which is supported by current scholarship e.g. Wang et al. (2023), who argues that providing AI-powered tools may lead students to heavily rely on them, jeopardising academic integrity.

Another issue raised in previous studies is the limited cultural and contextual sensitivity of these AI-powered tools. Wang et al. (2023) urges that—despite the potential advantages that AI applications offer in language learning for international students—the ability of these tools to interact in a human-like, culturally sensitive, and contextualised way is limited. Such limitations deserve further research through Activity Theoretical approaches, to expose implications in different educational settings, various cultural backgrounds, and diverse social circumstances.

7. Conclusion

This paper critically examines the role of ITSs in facilitating personalised and adaptive learning experiences in selected International Baccalaureate schools in Qatar, focusing on how these technologies interact with societal motives and the broader educational landscape. It examines how teachers, coordinators, and educators perceive the

incorporation and utilisation of an ITS in their teaching practice, to support adaptive learning. The findings show that most teachers believed that an ITS holds potential benefits, to support teaching and learning. This study provides insights for educational stakeholders to better understand the activity of integrating ITSs in schools, to offer adaptive learning and personalised learning opportunities to enhance students' outcomes. It also suggests that researchers continue to apply Activity Theoretical approaches in educational contexts, to further develop a better understanding of its application, development, and improvement.

In an era of rapid technological advancements in many aspects, the integration of AI in education might seem inevitable. AI has been incorporated into the educational field, offering creative ways to mediate teaching and learning. The potentials of AI in education are broad and are still expanding, ranging from tailored learning experiences to effective administrative procedures, with further research needed to explore the applications and effectiveness of AI-powered tools including how ITSs mediate activity in educational settings.

This paper has limitations which include a single coder, a small-scale project with a narrow timescale, and a deeply contextualised study with limited generalisability. Additionally, although the process of recruiting participants in this research deployed multiple methods, still the number and diversity of participants is limited. Therefore, it is recommended that colleagues further expand the scale of the study to other educational stakeholders, in different regions other than Qatar, in diverse settings beyond K-12, to gain deeper insights on this topic.

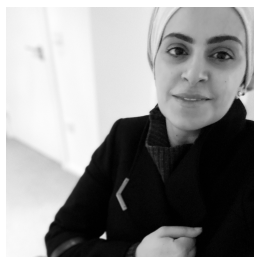
References

- Amanda, N., Andersen, F., Christian, R., Warnars, H. L. H. S., Ramadhan, A., Putra, A. S., Noordin, N., & Utomo, W. H. (2021). Learning Math for 1st Grade Primary School Students using Intelligent Tutoring Systems. *Turkish Journal of Computer and Mathematics Education*, 12(6), 2020–2030. <https://www.proquest.com/scholarly-journals/learning-math-1st-grade-primary-school-students/docview/2623926278/se-2?accountid=11979>
- Bower, M. (2019). Technology-mediated learning theory. *British Journal of Educational Technology*, 50(3), 1035–1048. <https://doi.org/10.1111/bjet.12771>
- Cong-Lem, N. (2022). Vygotsky's, Leontiev's and Engeström's Cultural-Historical (Activity) Theories: Overview, Clarifications and Implications. *Integrative Psychological and Behavioral Science*, 56(4), 1091–1112. <https://doi.org/10.1007/s12124-022-09703-6>
- Dolonen, J., & Dolonen, J. A. (2009). *Inclusion of teachers and students in the design of educational technology*. <https://www.researchgate.net/publication/263658316>
- Engeström, Y. (2001). Expansive Learning at Work: Toward an activity theoretical reconceptualization. *Journal of Education and Work*, 14(1), 133–156. <https://doi.org/10.1080/13639080020028747>
- Greenhow, C., & Belbas, B. (2007). Using activity-oriented design methods to study collaborative knowledge-building in e-learning courses within higher education. *International Journal of Computer-Supported Collaborative Learning*, 2(4), 363–391. <https://doi.org/10.1007/s11412-007-9023-3>
- Hunkenschroer, A. L., & Luetge, C. (2022). Ethics of AI-Enabled Recruiting and Selection: A Review and Research Agenda. *Journal of Business Ethics*, 178(4), 977–1007. <https://doi.org/10.1007/s10551-022-05049-6>
- Joaquim, S., Bittencourt, I. I., de Amorim Silva, R., Espinheira, P. L., & Reis, M. (2022). What to do and what to avoid on the use of gamified intelligent tutor system for low-income students. *Education and Information Technologies*, 27(2), 2677–2694. <https://doi.org/10.1007/s10639-021-10728-4>
- Joshi, S., Rambola, R. K., & Churi, P. (2021). Evaluating Artificial Intelligence in Education for Next Generation. *Journal of Physics: Conference Series*, 1714(1). <https://doi.org/https://doi.org/10.1088/1742-6596/1714/1/012039>
- Kamruzzaman, M. M., Alanazi, S., Alruwaili, M., Alshamari, N., Elaiwat, S., Abu-Zanona, M., Innab, N., Elzaghmouri, B. M., & Alanazi, B. A. (2023). AI- and IoT-Assisted Sustainable Education Systems during Pandemics, such as COVID-19, for Smart Cities. *Sustainability*, 15(10), 8354. <https://doi.org/10.3390/su15108354>
- Leont'ev, A. A. (1981). *Psychology and the language learning process* (C. V. James, Ed.). Pergamon Press.
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., Altman, D., Antes, G., Atkins, D., Barbour, V., Barrowman, N., Berlin, J. A., Clark, J., Clarke, M., Cook, D., D'Amico, R., Deeks, J. J., Devereaux, P. J., Dickersin, K., Egger, M., Ernst, E., ... Tugwell, P. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine*, 6(7). <https://doi.org/10.1371/journal.pmed.1000097>
- Mwanza, D. (2001). Where Theory meets Practice: A Case for an Activity Theory based Methodology to guide Computer System Design. In: *Proceedings of INTERACT' 2001: Eighth IFIP TC 13 Conference on Human-Computer Interaction, 9-13 July 2001, Tokyo, Japan*.
- Mwanza, D. (2002). *Towards an activity-oriented design method for HCI research and practice*. PhD thesis, the Open University. <https://doi.org/10.21954/ou.ro.0000dc95>
- Mwanza-Simwami, D. (2011). AODM as a framework and model for characterising learner experiences with technology. *Journal of E-Learning and Knowledge Society*, 7(3), 75–85. <https://doi.org/10.20368/1971-8829/553>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *The BMJ*(372). <https://doi.org/10.1136/bmj.n71>

- Pelletier, K. (2021). *2021 EDUCAUSE horizon report teaching and learning edition*. EDUCAUSE.
- Prem, E. (2023). From ethical AI frameworks to tools: a review of approaches. *AI and Ethics*, 3(3), 699–716. <https://doi.org/10.1007/s43681-023-00258-9>
- Pring, R. (2015). *Philosophy of educational research* (Third edition.). Bloomsbury Academic.
- Rieber, R. W. (1997). *The Collected Works of L. S. Vygotsky: The History of the Development of Higher Mental Functions* (R. W. Rieber, Ed.; 1st ed. 1997.). Springer.
- Singh, N., Gunjan, V. K., Mishra, A. K., Mishra, R. K., & Nawaz, N. (2022). SeisTutor: A Custom-Tailored Intelligent Tutoring System and Sustainable Education. *Sustainability*, 14(7), 4167. <https://doi.org/https://doi.org/10.3390/su14074167>
- Tominc, P., & Rožman, M. (2023). Artificial Intelligence and Business Studies: Study Cycle Differences Regarding the Perceptions of the Key Future Competences. *Education Sciences*, 13(6), 580. <https://doi.org/https://doi.org/10.3390/educsci13060580>
- Vincent-Ruz, P., & Boase, N. R. B. (2022). Activating discipline specific thinking with adaptive learning: A digital tool to enhance learning in chemistry. *PLoS ONE*, 17(11 November). <https://doi.org/10.1371/journal.pone.0276086>
- Wang, S., Christensen, C., Cui, W., Tong, R., Yarnall, L., Shear, L., & Feng, M. (2023). When adaptive learning is effective learning: comparison of an adaptive learning system to teacher-led instruction. *Interactive Learning Environments*, 31(2), 793–803. <https://doi.org/10.1080/10494820.2020.1808794>
- Wang, T., Lund, B. D., Marengo, A., Pagano, A., Mannuru, N. R., Teel, Z. A., & Pange, J. (2023). Exploring the Potential Impact of Artificial Intelligence (AI) on International Students in Higher Education: Generative AI, Chatbots, Analytics, and International Student Success. *Applied Sciences*, 13(11), 6716. <https://doi.org/10.3390/app13116716>
- Wang, Z., Yan, W., Zeng, C., Tian, Y., & Shi, D. (2023). A Unified Interpretable Intelligent Learning Diagnosis Framework for Learning Performance Prediction in Intelligent Tutoring Systems. *International Journal of Intelligent Systems*, 2023. <https://doi.org/10.1155/2023/4468025>
- Yu, H., & Shah, N. (2021). Role of 5G and Artificial Intelligence for Research and Transformation of English Situational Teaching in Higher Studies. *Mobile Information Systems*, 2021. <https://doi.org/10.1155/2021/3773414>
- Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – where are the educators? *International Journal of Educational Technology in Higher Education*, 16(1). <https://doi.org/10.1186/s41239-019-0171-0>

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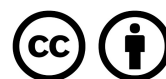
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