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The Effect of using Augmented Reality Technology on the Cognitive Holding Power and the Attitude Towards it Among Middle School Students in Al-Qurayyat Governorate, Saudi Arabia

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Abstract: The current study was to use augmented reality technology (ART) in the science course (SC) at the middle school level in Al-Qurayyat Governorate, Saudi Arabia, and to assess how it affected the students' attitudes toward AR (ATAR) and cognitive holding power (CHP). The ART is utilized to enhance learning results, particularly when generating challenging, novel, and abstract scientific theories. The CHP measure, and the ATAR measure were developed for this research. 58 school students took part in this study. They have been split into two categories: the experimental group was in group one, and the control group was in group two. In each group, there were 29 students. Whereas the second group learned the SC through the conventional approach, the first group did it using ART. The outcomes demonstrated the first group (Experimental group) superiority. The study suggested that in order to improve students' understanding of scientific topics, it is essential to increase knowledge of the value of ART.

Keywords: Augmented reality technology, Cognitive holding power, Attitude towards augmented reality, scientific concepts.

1 Introduction

The growth of smart technology has resulted in about radical changes in the area of education, notably in regard to the approaches taken for classroom instruction and learning. In order to enhance the educational experiences and academic achievements of their participants, schools of higher education can incorporate several developing innovations that provide significant didactic advantages. In intelligent surroundings with order to find suitable, Augmented Reality (AR) enables interaction between people and computers. The achievement or failure of academic results has been the subject of numerous problems in the past, raising concerns about the efficacy of conventional methods of education techniques and raising the need for modern teaching and learning approaches. Consequently, it is anticipated that a number of information system will be incorporated into the educational environment as a result of the growing importance of technology in daily life. Given that the younger folks are fascinated by technological advancements and innovations, the potential benefits of new technological advances in education, such AR and VR, will result in new educational resources in both education and training. For the purposes of teaching complex terminology, which is challenging to impart in traditional schooling, the utilization of digital technologies in the classroom is essential. Whereas the tools of traditional instructional models, particularly individual learning and self-learning, offer answers to the problems the learning curriculum faces (Baran et al. 2020).

Technology known as augmented reality allows for the real-time presentation of computer-generated virtual picture data in both the indirect and direct real-world surrounds. The solitary, teacher-centered, lecture-based education, and text-bound classroom are replaced by rich, student-focused, interactive learning experiences when using innovation educational tools, according to study. Technological developments have been whether directly or indirectly incorporated into many plans and programs for schooling by administrations of various nations due to its acknowledged promise for supporting student learning and development of learning skills, competences, and capabilities (Abad-Segura et al. 2020). Among all of these factors, a professor's approach regarding information technology may be crucial for acceptance, incorporation, and use effectiveness for a positive educational outcome. According to studies, the behavior of the teachers who actually determine how to use information technologies in the classroom will determine how well they are implemented. Not only do attitudes affect initial acceptance, and also subsequent behavior. Various studies support the idea that comprehending attitudes is crucial since attitudes might impede the introduction of new technologies. Based on the Diffusion of Innovation Theory, people's attitudes forward towards a technology are one of the important factors in its acceptance; hence it is assumed that having a positive outlook about innovation is a necessity

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for the successful pedagogic utilization information. The Technology Acceptance Model, on the other hand, emphasizes the importance of adopting a positive perspective to innovation before embracing it (Islahi and Nasrin 2019).

Significant influences also exist on the setting and length of learning and education. This technology is becoming more closely related to other cutting-edge technologies, including big data as well as e-learning, and it has been also getting nearer to the business and educational realms. Due to the diversity of teaching methods, continuous learning techniques combined with cutting-edge innovations, and instructional aims and purposes of creating novel solutions, the usage of AR in academic performance has acquired increased popularity. This is clearly seen in aspects of researching psychology predicated on psychological methods as well as components of teaching personalities like intellectual ability, informative design characteristics, and motor control (AL-Sehaem 2022). AR, which relates to the fusion of the actual environment that human live in with online reality in attempt to produce a brand-new reality that gives advantages above those offered by the two, seems to be one of the fundamental concepts that digital teaching has provided us. The new structure is regarded as a form of virtual reality, which uses a computer to show the real environment along with certain multiple virtual aspects about the real environment (factual reality) that were never actually a part of it. With the inclusion of images, sounds, or videos, the learner can more easily and thoroughly comprehend the "the content" of the educational information. A modern method in the educational procedure that is based on the digital realm is ART, in in addition to considering the idea of academic personalization in education, which claims that each learner learns in accordance with their capabilities. It strengthens and promotes continuous learning such that the student can handle the overflow of cognitive knowledge and continual growth (Aldalalah et al. 2019).

Traditional schooling places a strong emphasis on repetition as the primary instructional strategies and presented various as the primary value oriented. AR is used in teaching to shift passive into active and concrete into visual by employing contextual as a link between the classroom and realities. The progressive implementation of augmented reality technology (ART) in the education sector enhances students' independent and cooperative scenario learning techniques. This "situational turn" has developed into a crucial component of science education. The underlying philosophies of improving the educational development include situational learning and conceptualism. Context is the cornerstone of teaching, as per situation - specific learning economic theories point of view. There is no need for learning if it is kept away from the actual situation (surroundings) (X. Zhao et al. 2020). By altering the verbal and visual format of the assessment data in accordance with the concepts of time and space contiguity used in curriculum strategies, researchers contend that this both spatial and temporal imbalance could be filled. The display of relevant learning elements that must be mentally integrated in order to create new information is covered by both principles. According to the spatial adjacency concept, similar strategies must be placed geographically close to one another in order to divert learners' concentration from search activities that do not advance learning. Furthermore, in order to eliminate the requirement for knowledge to be retained for a longer amount of time, the temporal contiguity principle mandates the presenting of relevant information simultaneously (Rayan 2020). In order to create an integrative structure of content-related knowledge, researchers set out to exhibit measurement results as immersive virtual and arrange them in real time alongside the relevant material things utilizing augmented reality (AR) technology as a visualizing tool. The fundamental goal of augmented reality is to improve human cognition by incorporating virtual elements into actual situations (Aldalalah et al. 2019).

Figure.1 shows how the first Augmented Reality Systems (ARS) were typically built using three primary building blocks: the infrastructural tracker unit, the baseband processor, and the visual unit. The Infrastructure Tracker was in charge of gathering information from the physical world and transferring it to the Processing Unit, which combined it with virtual information and transmitted the resulting information to the Visual Unit's Video Out component. For some implementations, the Infrastructure Tracker Unit needed a Video In to collect the necessary data. AR has the potential to give learners an enjoyable and collaborative learning opportunity. With AR, the real world is enhanced with virtual elements, improving students' learning opportunities by overlaying images, video, texts, and soundtrack on top of the actual environment. Even for abstract material, the method makes knowledge more concrete and practical (Kwon et al. 2019). Through involvement and interaction with the educational material, it is hoped that employing AR would help students attain improved learning results. Analyzing information and concepts related to logical reasoning and decision-making is the activity of analytical analysis. Students should think in this way in order to solve complicated challenges in science study (Elloumi 2022). Students must use AR-based learning materials in order to analyze more analytically than they would otherwise. By using simple drag, drop, grab, and flip actions, students can engage with virtual elements and get around some of the constraints of the traditional teaching model. Fields of study should start with physics because it serves as the foundation for many engineering ideas and theories. There has been a requirement for a training tool that may assist students in visualizing ideas and occurrences since sometimes it might be challenging for pupils to grasp the ideas (Faridi et al. 2021).

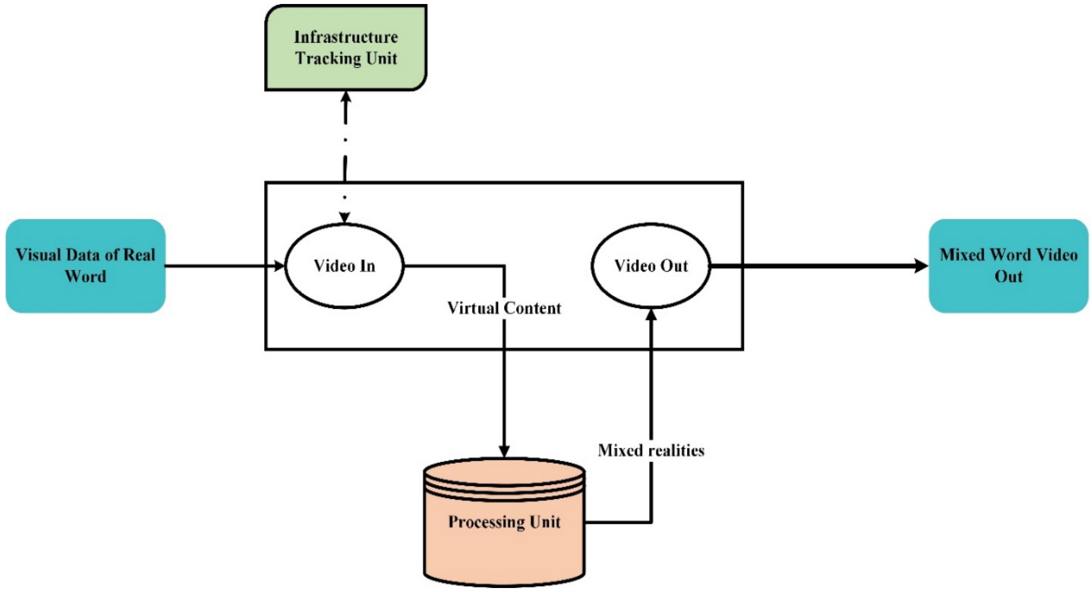

Fig. 1: Augmented Reality System.

These ideas of cognitive structures and concepts of learning environments combine to form the idea of cognitive hiding power (CHP). It defines cognitive holding capability for children to involve in first- or second-order cognitive processes, as the pressure from the environment. The following tasks that pupils complete lead to this press. What kids learn is determined by these assignments. A task is made up of a goal and a series of actions required reaching that goal. Based on their own internalized cognitive system as well as the external resources and CHP of the work context, students design their assignments. The degree to which a situation forces pupils to use various types of cognitive processes in attempt to complete the tasks they are given is referred to as the environment's cognitive holding power (Taloba 2022). A school environment that primarily requires students to use methodological approaches is one in which the ecosystem sets objectives for the student that may be directly attained through the use of particular procedures that are already in place. This kind of environment is said to have first-order CHP. Second-order CHP is thought to exist in learning environments that deliberately push students to use second-order processes (Vanneste et al. 2020).

Researcher anticipates more intentional innovation use for educational determinations by both students and educators as a result of these activities. Increasing the amount of student-centered instruction has indeed been one frequent objective for the use of one-to-one innovation to improve student learning outcomes. According to research, using technologies as cognitive aids to comprehend complicated learning resources with a lower cognitive load can assist pupils overcome challenges. Mobile computing devices (MCDs), in particular tablets and smartphones could offer fresh educational experiences. MCDs had the inimitable ability to give students an internet connection and movement. These two qualities enable teachers to support students' inquiry-based learning in a variety of settings, including those outside the traditional classroom (Islahi and Nasrin 2019). According to the study, media viewpoints like movies, TV, and computer games can be more than just sources of entertainment. They are generally employed as pleasure tools, which makes it possible to employ them for researching for interactions. Learning the employment of distraction tools is referred to as infotainment. E-learning, commonly referred to as separated training, is the process of using the Internet to improve performance and data. The goal of this project is to use AR Technology to give students a pleasurable learning experience. In this study, augmented reality's impact on e-learning systems in Saudi Arabian institutions is examined. Even though the majority of Saudi students take linguistic and social science subjects that require reading, scientific courses are teacher-centered and require students to pay attention to and obtain information. Educators exert control over what is read by forbidding pupils from studying science texts in-depth. The results of the tests reveal any lack of comprehension or interest inside the science textbooks. It is well known that Saudi grade 4 children perform poorly on international research testing projects (Lee, Kim, and Hwang 2019).

1.1 Research questions

The main question of the research can be formulated as follows:

What is the effect of the using ART on the CHP and the ATAR among middle school students in Al-Qurayyat Governorate, Saudi Arabia?

From the research questionnaire, three sub-questions branch were developed that are described as follows:

1. What is the effect of the using ART on the CHP?
2. What is the effect of the using ART on the ATAR?

2 Related Works

Technologies for augmented reality offer significant potential in a variety of fields where data communication speed is essential. This works particularly well for schooling. Augmented reality (AR) is becoming more widely accepted in a variety of sectors, particularly in academic contexts. Following the Covid-19 epidemic, home-based education has become an actuality and is now in force all over the world. Training using augmented reality applications will aid students in understanding educational materials in a more imaginative way than ever before. The use of augmented reality in developed country perspectives has not been thoroughly studied. Thus, it is important to comprehend the mechanics of augmented reality consumption to encourage and inspire students to use this incredibly creative and effective sort of technology in their studies. A framework that incorporates the Task-Technology Fit (TTF) and UTUAT2 concepts was presented and evaluated by the researchers in light of this. The implementation of augmented reality in academic contexts is discovered to be positively influenced by task technology suitability, facilitating conditions, facilitating conditions, social power, facilitating conditions, and hedonic motivation, while cost value is discovered to have minimal effect on psychological intent. This theory accounts for 49% of the variation in the purposeful use of AR in academic settings. The outcomes of this research will add to the body of expertise and enhance understanding of the processes and behaviors of AR adoption from the perspective of emerging economies. The study outlines the observations' theoretical approaches and operational consequences. Performance won't increase if the system with a low TTF construct is used (Faqih and Jaradat 2021).

Conventional photography learning technologies are unable to offer photographic practice while offering academic material or provide real-time photographic instruction based on the surroundings. By establishing a realistic educational environment, mobile augmented reality (AR) technologies offer a fresh approach to resolving these issues. To bridge theoretical concepts, a cutting-edge AR-based mobile photography app (ARMPA) is created. The ARMPA may promptly and simultaneously show the conceptual material of photography in the manner of text and photographs following trainees' commercial implementation depending on the learning-by-doing educational approach. Additionally, it may offer real-time engagement and direction to students by utilizing AR environmental sensing technologies. Conventional methods such as pre/post tests and surveys are used to evaluate the impact of ARMPA on way to gather information and cognitive effort. The study assesses and retrieves four electroencephalograms (EEG) anxious state indices, comprising involvement, relaxation, curiosity, and attention to objectively evaluate the efficacy of ARMPA from a psychological and cognitive standpoint. In comparison to conventional two-dimensional applications (APP), ARMPA increases learning benefits and reduces cognitive demands for students. When compared to the two-dimensional group, individuals in the AR collective experience more positive emotional states. This study offers some evidential basis for the use of augmented reality in smartphone photography. Mobile phone cameras frequently have low resolution, which results in photographs that are difficult to expand or print well. (G. Zhao et al. 2022).

Students frequently find it challenging to study physics since ideas like electric, magnetic, and sound is not visible to the unaided eye. Emerging innovations, including AR, can revolutionize teaching by keeping complex ideas apparent and approachable to beginners. The study demonstrates a HoloLens-based AR system that teaches users about the unseen electromagnetic phenomena associated with audio speakers, and the study uses qualitative and quantitative methods to assess the advantages of AR technology. The study track education (information gains and transference) and cooperative knowledge-sharing behaviors explicitly. The findings show that while AR usually has a novelty influence, certain academic AR visualizations can be both helpful and harmful to learning. These visualizations assisted learners to know structural models and spatial content but hampered their comprehension of kinesthetic material. Additionally, AR supported collaborative learning by offering a representation of common ground that enhanced interaction and peer instruction. These impacts are highlighted in this study, along with aspects that support collaborative learning among students using augmented reality apps (e.g., co-located depiction, quicker accessibility to resources, stronger grounded) or hinder it (e.g., tunnel vision, disregarding kinesthetic input). Because of its limited area of view, actual use fell well short of the vast (Radu and Schneider 2022).

In addition to supporting students' understanding of nuclear energy usage and radioactivity emissions, a subject associated with a socio-scientific issue (SSI) that requires complex rationality taking into account scientific proof and various views, the research examined 47 8th-grade educators in a recently created educational environment that incorporates mobile AR innovation. To determine how the learners' previous experience and context-specific epistemological explanation affected their participation in the educational environment and socio-scientific reasoning (SSR) effectiveness after the training, the research used fractional least squares hierarchical linear modeling. Educators' reactions to the expertise pretest, which evaluated their previous information regarding the SSI, the pretest questionnaire, which evaluated their context-specific epistemological rationalizations, the Cognitive and Emotional Engagement Survey (CEES), which was administered immediately after the AR actions, and the posttest, which evaluated their socio-scientific reasoning effectiveness, are among the data gathered. According to the findings, individuals' participation in the surroundings can be predicted by their context-specific epistemological reasons, and their SSR effectiveness can be predicted, albeit in various ways, by their previous information and trust in justification by authorities. The findings add to a concept of personalized epistemology within the setting of incorporating AR technology for the understanding of SSI and offer insights into how to enable learners with various personal attributes to study with these technologies. Since the information was gathered through respondents to a questionnaire, it is possible that pupils would not express their emotions honestly (Chang, Liang, and Tsai 2020).

People may interface with virtual things that are incorporated into the actual environment and display in the exact location in real-time due to augmented reality technologies. This meta-aim analysis is to categorize the many learning methods that have been employed utilizing AR. The study technique depends on an organized investigation of the internet sources Taylor Francis, Springer, Science Direct, Web of Science, and Scopus for relevant material. The terms "AR in education," "learning techniques," "integrated techniques," and "AR education and learning" were employed in the search. According to the findings of this meta-analysis, Augmented Reality is mostly used in academia through knowledge acquisition, game-based learning, cooperative learning, and practical training. These observations will give academics direction on the instructional methods that employ AR and its possibilities in learning, which will then stimulate extensive research on how teaching approaches utilizing AR applications can be effectively implemented in education and learning. This approach has consumed more time (Hanid, Said, and Yahaya 2020).

The use of AR in teaching has prospects to enhance student achievement since it is a novel technique to bring virtual reality into the physical world. By creating an institutional site called iEN, which provides several technologies that focus on education, including AR experimentation, e-textbooks, training games, short videos, and TV channels, the Saudi Ministry of Education incorporated technology into its education sector. Due to this program, Saudi Arabia was stronger prepared to switch to virtual learning, which allowed for a quick and simple change in the educational process during the coronavirus epidemic. The benefits of employing QR codes as an AR to improve student achievement in Saudi education were investigated in the current research. The results revealed that learners did not encounter any technical glitches when incorporating technology into their instructional strategies and that student who used QR codes in their training achieved greater levels compared to those who did not. Therefore, could be predicated on their generation's use of technologies, that became a regular part of their existence (AlNajdi 2022).

Examining the importance of social, personal, behavioral, and cognitive factors in learners' behavior intent towards e-learning at Saudi Arabian educational institutions, adds to the body of studies on the efficacy of e-learning via the AR application. To gather information from 152 graduate and postgraduate students from Jeddah, Saudi Arabia, convenient sampling was utilized. The hypothesized hypotheses' route modeling was investigated using the partial least squares (PLS)-structural equation modeling (SEM) approach for data processing. The social cognition theories elements were also used to examine the suggested system for learners' behavior intention toward augmented reality education. It was shown that the learners' cognitive involvement and behavior intent toward e-learning are favorably influenced by personal, social, and psychological consequences. Additionally, the findings showed that the mediation impact of cognitive engagement is how individual, social, and emotional aspects influence the learners' behavioral intent towards e-learning. The study outcomes showed that the augmented reality software had pushed the children to learn. As a result, academic institutions should switch from using old e-learning methods to more modern ones like augmented reality. It is more challenging to compare various groups when there are no entire fit statistics available (Kamarudin et al. 2021).

Additional qualitative study is required, though; since it can help us better understand how AR might enhance learning and knowledge creation in science classrooms. It is crucial to look at how students and educators feel about their experiences using AR. This study intends to provide light on their perceptions of training, motivation, perspective, and expertise concerning augmented reality technology. A real case approach was taken. A high school's 40 fifth, sixth, seventh, and eighth-grade students participated in the study, along with 10 science professors. The SPACE 4D program was utilized in the study for three weeks to cover the topics of "Moon, Earth, and Sun," "Solar System and Beyond," and "Solar System and Eclipses." After the 12-hour class, surveys with every student were conducted. Students claimed that AR boosts their motivation and attention, makes studying easier, and keeps them from becoming tired. Additionally, educators claimed that AR is beneficial and that it enhances concentration, information retention, and enthusiasm. It also concretizes abstract notions. In this way, technology may be used in scientific classes to engage students, assist them in overcoming preconceived notions, alter their attitudes, and produce better outcomes (Arici, Yilmaz, and Yilmaz 2021).

The crucial component to the success of smart glasses, like with any new growing technology, is user acceptability.

This research sought to determine how in-service teachers perceived the variables affecting their decision to utilize augmented reality smart glasses. 91 elementary and secondary school instructors enrolled in the experiment, which was performed in January 2021. Instructors were first given access to smart glasses' technical specifications and specialized features online. They were then required to respond to open-ended queries on an internet survey depending on the Technology Acceptance Models (TAM) conceptual foundation. The large numbers of instructors want to employ smart glasses in their classrooms, according to the qualitative approach of their responses. Additionally, it was shown that educators agree smart glasses are beneficial for both education and teaching (e.g., by improving students' enthusiasm). As per educators' conceptions, smart glasses' interoperability with them and performance expectancy like infrastructure, technological and pedagogies instruction, the availability of instructional material, low price, and assistance from teacher management are additional factors that could motivate them for using them. Additionally, a tiny percentage of instructors mentioned security and medical problems as reasons they would not use smart glasses. This report offers recommendations to help this new technology be used in classrooms successfully. In this approach, the weaknesses relate to the participant behavior variable, which must necessarily be assessed using subjective criteria like behavioral intention (Kazakou and Koutromanos 2022).

The study intends to ascertain middle school students' attitudes regarding augmented reality (AR) apps and examine the effects of educational material created with these technologies on their academic performance and course perspectives. In this research, intact classes at two distinct schools with a combined enrollment of 100 students in middle school in seventh grade have been randomly allocated to either the experimental group or the control group using quasi-experimental methods. The controlled group has done the identical scientific training modules as the experimental class utilizing textbooks and conventional techniques for the "Solar System and Beyond" module. It has been discovered that contributors in the experimental group had greater performance levels and more favorable opinions regarding the class than the control group's students. The outcomes also showed that the learners were content and intended to keep using augmented reality apps in the future. Furthermore, when utilizing AR applications, they exhibited no indicators of fear. Additionally, a favorable, substantial, and moderate link between the experiment group's pupils' educational performance and attitudes was discovered. The biggest drawback of quasi-experimental research is the lack of randomized which makes it difficult to conclude (Sahin and Yilmaz 2020).

3 Methodology

The following study question was investigated using a two group’s exploratory approach using a quasi-experimental approach: "There has been no significant variation between the mean results of the experimental group and the control group at the CHP, and ATAR."

3.1. Participants

The research community consisted of all students of the second grade of middle school students at Al-Qurayyat governorate – Saudi Arabia during the academic year 2021/2022. The sample was chosen from Majd Al-Uloom School in Al-Qurayyat governorate in an intentional manner, which contains three classes in the second grade. Two classes were chosen randomly from them, so the sample number reached (58) students, (29) students for each class. This school was chosen because it is one of the schools that adopt projects for employing technological innovations, in addition to the availability of the necessary tools and capabilities to apply the research in it from laboratories equipped with many computers and high-speed internet, and to ensure the homogeneity of the research sample that was selected from one school. The participant’s demographic characteristics have been represented in table.1.

Table 1: Samples demographic profile.

Measures	Items	Counts	Percentage
Age	< 13yrs	19	33.7
	13-14yrs	26	44
	>14yrs	13	22.3
Total		**58**	**100**
Group	I	29	50
	II	29	50
Total		**58**	**100**

3.2. Procedures

The current research was part of a larger cohort study that looked at middle school pupils in Saudi Arabia's Al-Qurayyat Governorate to see how using ART affected their CHP and how they felt about it. A total of 58 students have been randomly selected for the evaluation. Participants have been required to respond to a section of a composite questionnaire, which included demographic questions. The current study gathers information from the second grade of middle school students at Al-Qurayyat governorate – Saudi Arabia during the academic year 2021/2022. Each student offered their full permission. Figure.2 depicts the conceptual framework for this study.

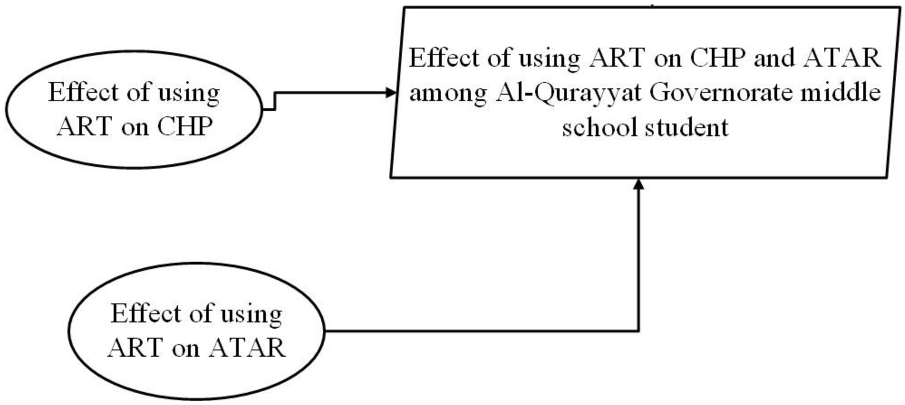

Fig. 2: Conceptual framework

3.3. Measures

The ATAR among school students has been measured using 17 items, the CHP of the first order (teacher order) has been measured using 14 items, and the CHP of the second order (promoting the practice of cognitive and metacognitive activities in the learning environment) has been measured using 16 items, all of which were adopted from previous studies' correct scale items. The 5-point Likert scale used to gauge how the respondents felt about these questions remained at 5 (strongly agree)-to-1 (highly disagree). Table.2 displays the ATAR and CHP scale items and measurement items for middle school students.

Table.2: Items for measurements.

Variables	Items	Scale items
ATAR among students	ATAR 1	I enjoy learning my lessons when using augmented reality
	ATAR 2	I prefer the lessons which presented by using augmented reality.
	ATAR 3	Using augmented reality increases my Engagement in the class.
	ATAR 4	Using augmented reality is not fun and distracts me.
	ATAR 5	I feel happy when the teacher is using augmented reality in teaching.
	ATAR 6	I eagerly await the class using augmented reality.
	ATAR 7	Using augmented reality enables me to better understand my new lessons.
	ATAR 8	The use of augmented reality has become essential to my learning well.
	ATAR 9	Using augmented reality wastes class time.
	ATAR 10	The use of augmented reality makes it easier to understand new and
	ATAR 11	Using augmented reality increases my ability to solve my lessons
	ATAR 12	Using augmented reality increases my ability to remember information.
	ATAR 13	Using augmented reality increases my participation and collaboration
	ATAR 14	I want all teachers to teach using augmented reality.
	ATAR 15	I search online for lessons explained using augmented reality.
	ATAR 16	I refuse to use augmented reality because it distracts me.
	ATAR 17	Hope that augmented reality will be used in teaching all subjects.
CHP of the first order (teacher effect) (CHPT)	CHPT 1	The instructor challenges the class to connect what they already know.
	CHPT 2	The teacher exhorts the students to adhere to instructions.
	CHPT 3	I believe I must mimic the teacher's actions.
	CHPT 4	I learn everything from the educator.
	CHPT 5	The teacher exhorts the learners to imitate what they do.
	CHPT 6	The educator exhorts students to experiment with new concepts.
	CHPT 7	The teacher exhorts students to conduct independent research.
	CHPT 8	I depend on the educator to make connections for me.
	CHPT 9	I mimic the teacher's actions.
	CHPT 10	In order to verify their findings, the teacher motivates students to inquire.
	CHPT 11	I obeyed the teacher's instructions.
	CHPT 12	Students have been urged by their teacher to complete their assignments
	CHPT 13	I look to the teacher for fresh concepts.

	CHPT 14	The educator advises students to compare their findings to what they
CHP of the second order (pushing the learning environment to practice cognitive and metacognitive activities) (CHPS)	CHPS 1	I offer queries to verify my findings.
	CHPS 2	I believe I must test out fresh concepts.
	CHPS 3	I believe I must gather facts for myself.
	CHPS 4	I compare my findings to knowledge I already have.
	CHPS 5	I believe that in order to verify my findings, I must inquire.
	CHPS 6	I believe I need to compare my findings to knowledge I already have.
	CHPS 7	I make connections between what I learn.
	CHPS 8	I go for my desires.
	CHPS 9	I believe I must follow the teacher's instructions.
	CHPS 10	I explore fresh concepts.
	CHPS 11	I believe I need to connect the information I learned.
	CHPS 12	I have no reservations about my outcomes.
	CHPS 13	I follow my own processes.
	CHPS 14	I find information for myself.
	CHPS 15	I work exactly as shown.
	CHPS 16	I believe I must perform my duties exactly as indicated.

3.4. Validation procedure for measurement

In this investigation, the applicability of a collection of items utilizing Cronbach's alpha and the validity of each scale are both investigated. Cronbach's alpha seems to be a measure of inner consistency or simply how tightly a set of things have been connected. It's not always true that a measure with a "high" alpha number was one-dimensional. Combining internal reliability assessment with other studies could add to the body of knowledge demonstrating the unidimensionality of the scales under investigation. Cronbach's alpha seems to be a coefficient indicating reliability rather than statistical measurements. The scale purification techniques applied in this work were those Anderson and Gerbing (Anderson and Gerbing 1988) suggested. This study examined item loadings using standardized residuals, normalcy, and modification indexes. Items with low factor loading have indeed been taken from the scales. The rest items were then reviewed again to verify sure the original article's assumptions about the measures had not changed. Cronbach's alpha and Composite Reliability (CR) have also been evaluated to support the conceptual reliability of the measurement items. To determine whether each construct has CR, the Average-Variance-Extracted (AVE) and factor loadings have also been examined. Cronbach's alpha, factor loading, and AVE all have reference values of 0.60, 0.65, and 0.60, correspondingly.

3.5. Data analysis

The science curriculum's " Heat power and waves " section was covered in classes by both groups. The control group finished the identical unit using textbooks & conventional techniques, whereas the experimental group used ART to complete it. The measures of " ATAR among students," "CHP of the teacher," and "CHP of the second order (pushing the learning environment to practice cognitive and metacognitive activities)" have been employed to compare the effects of the experimental and control groups on CHP and attitude toward middle school students. After the measurement models' reliability and validity have been initially evaluated, Pearson correlation analysis was carried out in attempt to confirm the developed hypotheses underlying the correlations.

4 Research findings

The acceptable range for the alpha coefficient of each scale seems to be a topic of continuous debate in academia. According to a few experts, who agreed with a ranging of 0.7 to nearly 1, an unique thought or if the respondents in the study region have indeed been still acquainted with it demand for an alpha coefficient of 0.6 or greater. According to this research, an alpha coefficient of 0.6 or higher is sufficient. Items having an item-total correlation coefficient of ≥ 0.3 are considered to have shown reliability, on the other hand, < 0.3 item-total correlation coefficients are removed from the scale. The reliability coefficient for Cronbach's alpha in this research varied from 0.812 to 0.927. It's important to note that all scales' measured variables have such a substantial correlation with the overall item. Table.3 represented the preliminary test outcomes for the experimental group (29) and control group (29) middle school students.

Table 3: Preliminary test results of validity and reliability (N = 58).

Likert-scale construct	**Variables**	**Experimental group**				**Control group**			
		Normal	**Cronbac**	**AVE**	**CR**	**Normal**	**Cronbach'**	**AVE**	**CR**
	ATAR 1	0.746				0.758			
	ATAR 2	0.768				0.891			

ATAR among students	ATAR 3	0.795	0.927	0.850	0.827	0.909	0.927	0.850	0.827
	ATAR 4	0.737				0.893			
	ATAR 5	0.778				0.880			
	ATAR 6	0.723				0.742			
	ATAR 7	0.734				0.764			
	ATAR 8	0.746				0.793			
	ATAR 9	0.728				0.735			
	ATAR 10	0.726				0.776			
	ATAR 11	0.699				0.721			
	ATAR 12	0.654				0.733			
	ATAR 13	0.742				0.742			
	ATAR 14	0.688				0.725			
	ATAR 15	0.691				0.724			
	ATAR 16	0.646				0.694			
	ATAR 17	0.699				0.652			
CHP of the first order (teacher effect) (CHPT)	CHPT 1	0.762	0.914	0.874	0.923	0.741	0.914	0.874	0.923
	CHPT 2	0.703				0.687			
	CHPT 3	0.704				0.690			
	CHPT 4	0.725				0.645			
	CHPT 5	0.762				0.698			
	CHPT 6	0.781				0.761			
	CHPT 7	0.753				0.702			
	CHPT 8	0.760				0.701			
	CHPT 9	0.689				0.724			
	CHPT 10	0.708				0.761			
	CHPT 11	0.744				0.780			
	CHPT 12	0.698				0.752			
	CHPT 13	0.683				0.759			
	CHPT 14	0.597				0.688			
CHP of the second order (pushing the learning environment to practice cognitive and metacognitive activities) (CHPS)	CHPS 1	0.642	0.812	0.761	0.876	0.706	0.812	0.761	0.876
	CHPS 2	0.655				0.742			
	CHPS 3	0.793				0.697			
	CHPS 4	0.747				0.682			
	CHPS 5	0.665				0.596			
	CHPS 6	0.561				0.641			
	CHPS 7	0.488				0.654			
	CHPS 8	0.515				0.791			
	CHPS 9	0.659				0.745			
	CHPS 10	0.574				0.663			
	CHPS 11	0.642				0.598			
	CHPS 12	0.844				0.486			
	CHPS 13	0.898				0.514			
	CHPS 14	0.702				0.658			
	CHPS 15	0.716				0.578			
	CHPS 16	0.778				0.642			

Items having an item-total correlation coefficient of ≥ 0.4 are considered to have shown reliability, on the other hand, < 0.4 item-total correlation coefficients are removed from the scale. The reliability coefficient for Cronbach's alpha in the post test result (PLS) varied from 0.847 to 0.924, in which the experimental group has attained better outcome than control group. Table.4 represented the post-test outcomes for the experimental group (29) and control group (29) middle school students.

Table 4: Post-test results of validity and reliability (N = 58).

Likert-scale construct	**Variables**	**Experimental group**				**Control group**			
		Normal	**Cronbac**	**AVE**	**CR**	**Normal**	**Cronbach'**	**AVE**	**CR**
	ATAR 1	0.861				0.742			

ATAR among students	ATAR 2	0.758				0.764			
	ATAR 3	0.891				0.793			
	ATAR 4	0.909				0.733			
	ATAR 5	0.893				0.742			
	ATAR 6	0.880				0.725			
	ATAR 7	0.869				0.741			
	ATAR 8	0.734	0.847	0.878	0.815	0.687	0.856	0.842	0.803
	ATAR 9	0.729				0.690			
	ATAR 10	0.910				0.702			
	ATAR 11	0.883				0.701			
	ATAR 12	0.872				0.724			
	ATAR 13	0.864				0.759			
	ATAR 14	0.786				0.688			
	ATAR 15	0.843				0.706			
	ATAR 16	0.897				0.641			
	ATAR 17	0.701				0.654			
CHP of the first order (teacher effect) (CHPT)	CHPT 1	0.716				0.791			
	CHPT 2	0.775				0.486			
	CHPT 3	0.742				0.514			
	CHPT 4	0.697				0.658			
	CHPT 5	0.682				0.845			
	CHPT 6	0.596				0.892			
	CHPT 7	0.641	0.912	0.842	0.916	0.701	0.869	0.825	0.913
	CHPT 8	0.654				0.758			
	CHPT 9	0.791				0.891			
	CHPT 10	0.745				0.909			
	CHPT 11	0.663				0.735			
	CHPT 12	0.598				0.776			
	CHPT 13	0.486				0.721			
	CHPT 14	0.514				0.724			
CHP of the second order (pushing the learning environment to practice cognitive and metacognitive activities) (CHPS)	CHPS 1	0.658				0.694			
	CHPS 2	0.578				0.652			
	CHPS 3	0.642				0.645			
	CHPS 4	0.698				0.698			
	CHPS 5	0.761				0.761			
	CHPS 6	0.702				0.761			
	CHPS 7	0.843				0.780			
	CHPS 8	0.897	0.927	0.896	0.867	0.752	0.854	0.778	0.845
	CHPS 9	0.701				0.742			
	CHPS 10	0.716				0.697			
	CHPS 11	0.775				0.682			
	CHPS 12	0.758				0.745			
	CHPS 13	0.891				0.663			
	CHPS 14	0.909				0.598			
	CHPS 15	0.893				0.843			
	CHPS 16	0.880				0.897			

The evaluation findings of this research demonstrate the reliability of the item analytic findings since Kaiser-Meyer-Olkin (KMO) = 0.876 > 0.5, Sig = 0.000 < 0.05. The rotational factor matrix suggests three factors for inquiry; these items had 62.827 > 50% of AVE and the third factor's coefficient of Eigenvalues has been equal to or greater than 1. Thus, this assessment affirms the presence of three components. These parameters have little influence on the observed variables in comparison to the hypothetical measures, demonstrating the scales' strong convergence, as shown in table 5.

Table 5: Post-test results of Correlation-coefficient matrix and AVE (N=58).

Variables	Experimental group			Control group		
	ATAR	**CHPT**	**CHPS**	**ATAR**	**CHPT**	**CHPS**
ATAR 1	0.768			0.861		
ATAR 2	0.784			0.891		
ATAR 3	0.795			0.909		
ATAR 4	0.784			0.880		
ATAR 5	0.843			0.869		
ATAR 6	0.838			0.734		
ATAR 7	0.819			0.910		
ATAR 8	0.774			0.883		
ATAR 9	0.832			0.864		
ATAR 10	0.825			0.786		
ATAR 11	0.862			0.843		
ATAR 12	0.734			0.897		
ATAR 13	0.856			0.701		
ATAR 14	0.847			0.716		
ATAR 15	0.825			0.775		
ATAR 16	0.819			0.850		
ATAR 17	0.800			0.703		
CHPT 1		0.864			0.876	
CHPT 2		0.798			0.895	
CHPT 3		0.869			0.761	
CHPT 4		0.857			0.927	
CHPT 5		0.820			0.854	
CHPT 6		0.834			0.772	
CHPT 7		0.828			0.774	
CHPT 8		0.742			0.838	
CHPT 9		0.857			0.894	
CHPT 10		0.874			0.872	
CHPT 11		0.838			0.698	
CHPT 12		0.812			0.845	
CHPT 13		0.774			0.645	
CHPT 14		0.841			0.765	
CHPS 1			0.778			0.637
CHPS 2			0.734			0.725
CHPS 3			0.795			0.721
CHPS 4			0.784			0.679
CHPS 5			0.846			0.832
CHPS 6			0.824			0.812
CHPS 7			0.859			0.845
CHPS 8			0.769			0.748
CHPS 9			0.775			0.774
CHPS 10			0.872			0.853
CHPS 11			0.743			0.784
CHPS 12			0.846			0.840
CHPS 13			0.883			0.854
CHPS 14			0.747			0.727
CHPS 15			0.865			0.837
CHPS 16			0.932			0.924
AVE	**52.294**	**57.681**	**62.827**	**50.372**	**55.795**	**58.621**
KMO =	**Sig = 0.000**					
Eigen values	**2.458**	**2.192**	**1.724**	**2.587**	**2.255**	**1.895**

Finally, correlation analysis was employed to assess both groups research hypothesis, showing that it is substantial when the level of statistical significance is high. The result shows how closely the variables utilized in the correlation assessment are correlated. Inappropriate components must be found using the VIF multicollinearity test.

Table 6: Correlation analysis (Post-test results).

Variables	ATAR	CHPT	CHPS
ATAR	1		
CHPT	0.065	1	
CHPS	0.121**	0.065*	1

* Coefficients at 0.05 significant level; ** Coefficients at 0.1 significant level

Less than two coefficients in the VIF findings could mean that the framework's components are not multicollinear. Each item's Sig coefficient exceeded 0.000, indicating that each item may have had an impact on it. These findings demonstrate that no model variables have been removed, and the regression test confirms that the evaluation criteria have been satisfied. The findings of the study on the effect of ATAR and CHP on middle school students are shown in table 6.

5 Discussion

The term cognition refers towards what happens in one's mind while they go about their daily lives. It encompasses things like concentration, observation, language use, and understanding, memorizing, studying, and making a decision (Preece et al. 1994). In order for students to engage in cognitive functioning, a scenario must either exert pressure on them or supply them with motivation. A student's effectiveness in addressing a learning assignment can be improved by CHP, as can that student's capacity to improve information retention as well as learning capabilities. To overcome these difficulties, it may be useful to enhance students' CHP skills. A university student's education and CHP can be enhanced by considering contexts, surroundings, and instructional techniques. Various learning contexts encourage students to practice cognitive skills at different levels (Xin 2008). In an interactive learning setting, like a flipped classroom, learners are more likely to apply higher-order thinking strategies like CHP. The capacity of augmented reality to grab and hold attention makes it appealing for use in education. This directly relates to cognition and the senses' function in understanding and interpreting the brain's mixed input of actual and digital inputs. CHP is essentially how humans interpret and react to the world surrounding them using their internal memories as well as reflexes as well as their exterior senses. The potential distractions that augmented reality instructional programs may bring about are yet another important issue for educators. People are suffering from cognitive overload as a result of the constant barrage of knowledge they encounter when awake. Children would be given yet another device to add to the toy boxes as they become increasingly absorbed in digital ones. If it hasn't already, parents and educators wonder when it will be too much. While the advantage of immersion is desirable and a negative trade-off, it considerably helps with information retention as well as recall. This demonstrates the superiority of the augmented reality program's instructional design. The "flash" and entertaining features of the augmented reality in the CHP design worry educators because they could be mistakenly seen as educational (Squire and Jenkins 2003).

The adoption of AR methods in classrooms and the predicted educational gains will depend on student attitude toward AR. Attitudes are people's reactions to things and circumstances that have a guiding or leading influence on events. In other words, attitudes are inclinations that lead people to adopt particular behaviors rather than actual behaviors themselves. The importance of attitudes is mentioned in the Technology Acceptance Model (TAM) is designed to illustrate the elements that influence people's acceptance of technology. According to the TAM, attitudes influence the intent that determines how behaviors are displayed. The utilization of technology directly depends on attitudes about it. Because people have different attitudes toward accepting new technologies, the integration procedure could result in adaptation or rejection of such technologies (Teo, Lee, and Chai 2008). The new technology's utilization in the classroom would depend on how the students feel about it. It could be asserted that in order to successfully integrate AR technology into academic settings, it is essential to understand student's attitudes toward AR applications. People born after the turn of the twenty-first century are known as "digital natives,". He claims that instead of tools like printed documents, these people are immersed by computers, phones, and video games, which this continual exposure to innovation causes people to think differently as well as process information in different ways. The usage of technology also has a number of negative effects (Alhumaid 2019). The usage of innovation in educational settings should be done in a controlled way to get rid of these adverse effects (Çetin and Türkan 2022).

Due to its potential applications in a number of industries, including industry, urban planning, museum exhibitions, including clinical psychology, AR technology has received a lot of attention. Researchers are always working to advance augmented reality in education. First, relevant papers were looked up in the Scopus and Web of Knowledge databases using terms like AR as well as science learning or science education in order to gain a basic understanding of how AR could aid learning in scientific education. In essence, researches involving empirical data or scientific subjects such as biology, astronomy, chemistry, or engineering have been chosen. Many image-based AR applications were created for science education. However, there are certain issues concerning the way these systems function. It is discovered that students thought the system method to be hard, the system's performance to be insufficiently stable (e.g., there have been system crashes), and also that technical staff support was required (Cheng and Tsai 2013). In order to overcome the conversation challenges that a more adaptable and controllable image-based augmented reality system (for example, a purpose permitting the alteration of variables to adaptively discover the connections among the Sun, Earth, and Moon) must be established. This would eliminate the restriction of asking kids to simply observe and describe the elements. To be more precise, it was thought that the AR system would include the ability to add and remove parts as well as change the speed of animations (Kerawalla et al. 2006).

6 Conclusion

The current research's objectives were to examine the effect of ART on the CHP and ATAR among middle school students in the Al-Qurayyat governorate of Saudi Arabia, as well as the impact of ART on the teaching of science courses. The current work also had the goal of examining the connections between these students' ATAR, CHP on first order (teacher effect), and CHP on second order. This study was predicated on a quantitative research model. Moreover, totally 58 middle school students were selected from the second grade and divided into two groups i.e., experimental as well as control group. Each group contains 29 students for assessment. In addition, preliminary and post-test are conducted to determine the superiority of the method. Students from the experimental group have been found to have higher CHP scores and more favorable opinions towards the ART compared to control group. This notable group variation can be viewed as proof of ART's beneficial effects. Further, Pearson correlation analysis was used to determine the correlation among ATAR among students, CHP on teacher effect (CHPT), and CHP on second order (CHPS). The result indicated that the students' CHP as well as attitudes towards the ART were found to be significantly correlated. There were no additional reliable relationships found.

Limitations of the study:

The current research limited to designing the sixth chapter entitled "Heat power and waves" in the science course of the second grade of middle school. This chapter was produced and presented by using ART. Halo AR mobile application were used for connecting the produced content with the quick response (QR) code, and to present 2d and 3d produced content over the book pages. The research tools were applied to a group of the middle school students at the Majd Al-Uloom School in Al-Qurayyat governorate, Saudi Arabia during the third semester of the academic year (2021-2022).

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Conflict of interest

The authors declare that there is no conflict regarding the publication of this paper.

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