



Effectiveness of Smart Project-Based Learning in Developing Artificial Intelligence Literacy, Social Studies Concepts, and Learning Motivation Among Middle School Students: An Analytical Study

Dima Saud Khaled Alsaud¹, Alia Abdullah Aljindi²

^{1,2}Education Technology Department, Faculty of Education,

King Abdulaziz University, Jeddah, Saudi Arabia

¹dimasaud@gmail.com, ²aaljindi@kau.edu.sa

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ABSTRACT

Artificial intelligence is increasingly becoming relevant in education, however, with limited success in adopting it in classrooms, particularly in social studies at middle school. The traditional pedagogical activities do not necessarily help them to become technologically aware, to what extent their level of conceptual knowledge and their motivation to learn. This research paper examined the possibilities of the smart project-based learning to enhance the artificial intelligence literacy, to comprehend the concept of social studies and learning motivation of the students in the middle-school. It utilized the quasi-experimental design that involved 40 students in Jeddah (experimental group comprising of 20 students and control group comprising of 20 students). Experimental group: The smart project-based learning program, with the integration of AI tools, prompt engineered and real-world social studies projects, has been used to teach the experimental group, and the traditional method has been used to teach the control group. An AI Literacy Scale and a Social Studies Concepts Test, Motivation Scale, and a performance evaluation rubric were used to gather data. The findings revealed that, post-test scores showed that the experimental group had much higher scores than control group in AI literacy, social studies concept acquisition and learning motivation. The results indicate that smart project-based learning provides a more interactive, meaningful and future-oriented learning experience than traditional learning approaches. The study finds that AI-assisted project-based pedagogy can empower the cognitive and motivation outcomes in middle-school education. The research implications to the classroom practice and curriculum development and AI integration in school education are discussed.

Key words: Smart project-based learning, artificial intelligence literacy, acquisition of a social studies concept, learning motivation, middle school students, educational technology.

1.INTRODUCTION

1.1 Introduction to the Study

Artificial intelligence is recognized as one of the most significant changes in modern education that has transformed the design and delivery of teaching, learning, and assessment. AI is being applied more in schools as a means to assist in personalized learning, real-time feedback, interactive content creation, and student-focused learning environments. Smart tutoring programs, customized learning systems, and generative AI applications have increased the opportunities with which classroom practice can be practiced by enabling students to explore concepts, solve problems, and generate knowledge in a more dynamic manner. This move is an indication of a wider change in education towards technology-enriched settings that equips students to engage in a fast-evolving digital world.

Digital competence has been made a central learning outcome and not a bonus skill alongside this development. Now students are not only supposed to use digital tools, but also to know, analyze, and use it in a responsible manner in their academic life. This encompasses the capacity to search information, analyze online content, communicate effectively using technological tools, and be critical of new systems like AI. Consequently, schools are increasingly being pressurized to incorporate meaningful digital learning that goes beyond passive consumption and into higher order thinking, creativity, and problem solving.

In this context, the role of technology-supported teaching as the means of enhancing engagement and learning results acquired growing significance. Educators are progressively embracing online solutions, multimedia tools, and AI-friendly software to transform education into a more engaging and student-centered experience. Nonetheless, the learning power of these technologies lies not just in its access, but in the way of intentional learning activities where students can actively implement knowledge. This is why integrating AI-assisted solutions with student-centered approaches like project-based learning can be viewed as a promising avenue towards enhancing not only the academic

knowledge but also future-oriented skills in middle school students.

1.2 Learning in the Social Studies context

The social studies field is one of the most valuable topics to discuss in the connection of innovative teaching methods as the students have to work with complicated concepts connected with the geographical, social, cultural, citizenship, and human interaction. In contrast to the subjects where students need to memorize isolated facts, social studies require interpretation, comparison, analysis, and development of relationships between ideas and real-life circumstances. The interaction of historical, social, and geographic factors is something that students are often required to know, and it cannot be learned without a deeper conceptual thought instead of remembering.

Although it is important, students often have problems with social studies due to the abstract nature of many of its concepts, their interrelationships, and contextual relativity. Conventional methods of teaching can be seen as delivering information in bits or teacher-centric form, which denies students the chance to explore, challenge, and utilise ideas in a meaningful way. This might lead to learners finding it difficult to relate ideas, hold conceptual knowledge or to be motivated. In this connection, social studies can be a good background to explore whether smart project-based learning with the assistance of AI tools can assist students in developing clearer perceptions, greater engagement, and meaningful learning outcomes.

1.3 Problem Statement

Although there is an increased relevance of artificial intelligence in modern education, not much has been done to enhance its application in real classroom activities, especially in disciplines like social studies. Despite the rise in exposure to digital tools and technology-based instruction in schools, there remains a prevalence of teaching practices that focus on traditional practices of explaining, memorizing, and delivering instruction through textbook. These methods might not be adequate in equipping students to engage in a knowledge-based and technology-driven environment in which digital competence, critical thinking and problem-solving are becoming learning outcomes. This is where the contrast between what AI provides and the classroom practice has been a significant educational issue.

This issue can be especially observed within the social studies classroom setting of middle schools, where the students are supposed to learn sophisticated and interrelated ideas about geography, society, culture, and human relations. Conventional teaching strategies might fail to facilitate learners in decoding such notions, translating them into real-life contexts and interacting with them in a purposeful and sustained manner. Consequently, learners can show poor conceptual knowledge, lack of motivation to learn, and lack of understanding of how new technologies like artificial intelligence can be productively applied in academic work. This gap is further increased by the lack of systematic possibilities to make use of AI tools in project-based and inquiry-oriented learning settings.

So, it is evident that there is a necessity to investigate the possibility of a smart project-based learning approach to

offer tangible educational value in this scenario. In particular, one should identify whether the use of AI-supported learning activities in social studies teaching can help students to gain a better level of artificial intelligence literacy, better their understanding of the concept of social studies and become more motivated to learn. Solving this issue will assist in clarifying the possibility of smart project-based learning to be an effective instructional reaction to the existing educational needs.

1.4 Research Gap

It is universally accepted in the literature that artificial intelligence and project based learning are two distinct areas of instruction that are educationally valuable. On the one hand, the research on AI in education has focused on the opportunities of its use in the context of individualized learning, interactive interaction, and the development of digital skills. Conversely, project based learning has been identified as one of the effective learner-based methods which encourages collaboration, critical thinking, creativity and practical application of knowledge. Nevertheless, the two research strands have provided valuable insights, which are still used separately, with little focus being placed on how they can be integrated into a single instructional model.

Another loophole is created in relation to the school curriculum like social studies. The current discourse of AI implementation in education is often predisposed to consider science, technology, mathematics, or computer-based learning situations in which digital tools are more likely to be implemented. There is a relative and limited number of studies that have focused on the role of AI-based instructional strategies in social studies education, especially in the middle school level. This is important as social studies demand conceptual knowledge, interpretation and real-life analysis, and interactive and inquiry-based learning can be enhanced with the help of smart technologies.

Additionally, the concomitant investigation of three significant conclusions in a single study has received little analytical focus including artificial intelligence literacy, social studies concept acquisition, and learning motivation. Other studies have frequently considered only one or two of these variables separately, but not their joint development using a clever project-based learning intervention. Thus, the current research aims at filling this gap by analytically discussing the question of whether smart project-based learning can be an effective learning process to enhance technological awareness, conceptual understanding, and motivational engagement among students in the middle school.

1.5 Aim of the Study

This study seeks to examine how effective smart project-based learning is in boosting the level of artificial intelligence literacy, social studies concepts acquisition, and learning motivation among middle school learners.

1.6 Study Objectives

The objectives of the study include:

- To test the impact of smart project-based learning on the artificial intelligence literacy of the students.

- To investigate how smart project-based learning can enhance the knowledge of the students on the concepts of social studies.
- To evaluate how smart project-based learning affects the motivation of students to learn.

1.7 Research Questions

The research questions to be answered in the study are:

- How does smart project-based learning impact the artificial intelligence literacy of middle school students?
- What is the effect of smart project-based learning on the learning of social studies concepts among students?
- How does smart project-based learning impact on the motivation of students to learn?

1.8 Significance of the Study

The research is also noteworthy as it deals with a critical modern challenge in the field of education: how to meaningfully, pedagogically and measurably incorporate artificial intelligence into classroom instruction. Dwelling upon the field of social studies in the middle school, the research broadens the discussion of the AI-facilitated learning not to the strictly technical subject matter but to the field in which the interpretative meaning and the ability to formulate concepts and situate them in a specific context play a crucial role. In this way, it helps to address the emerging demand of the use of instruction methods that involve both technological advancement and active learning, which is student-centered.

The research is significant to practice in education as well. Its results can offer valuable information to teachers who want to find more efficient methods to involve students, enhance the conceptual knowledge and develop digital competence with the help of real classroom practice. Moreover, the findings can guide curriculum developers and policy makers to appreciate the importance of integrating AI tools and project-based learning to update teaching methods and make school relevant to the present educational needs. In a broader context, the research is an empirical contribution to understanding whether smart project-based learning can be used to enhance academic and motivational growth in middle school students.

2. LITERATURE REVIEW

2.1. AI in Education

AI has gained more importance in education due to its ability to aid in teaching and learning in more flexible and interactive aspects. AI can help with content creation, feedback and assessment, as well as support lessons in teaching, which helps to reduce the routine workload and enables teachers to dedicate more time to facilitating and guiding. AI tools are useful in the learning process, enabling students to get explanations, search the information, and get instant feedback when studying. According to Feng and Carolus, AI in school education is not merely a technological tool but also an aspect that determines the way

in which students interact with knowledge and learning processes [6].

Personalization is a key advantage of AI in education. AI-based systems are able to adjust learning content, suggestions and assessment based on the needs of the students, their learning pace and their performance. This will enable learners to have a more personalized support as opposed to receiving a standardized method of teaching. The question-asking, idea-generating, and researching of topics can also be facilitated by AI allowing students to do this in a more dynamic way. Alfarwan et al. discovered that AI tools in the K-12 education sector tend to increase interaction, feedback, and differentiated support, but their usefulness relies on the guided and purposeful classroom utilization [1]. As such, AI in education is not only becoming important in terms of efficiency, but also in how it can transform learning to become responsive, exploratory and student-centered.

2.2. Artificial Intelligence Literacy

As AI systems become part of the learning process, communication and decision-making, artificial intelligence literacy has become a vital learning need. Feng and Carolus demonstrated that AI literacy in school education is no longer perceived as the mere familiarity with tools, but this concept is becoming a multidimensional one that comprises the knowledge, skills, attitudes, and psychological preparedness to work with AI systems [6]. According to their review, AI literacy should not only entail knowledge of how AI functions, but also a skill to assess, doubt and apply AI responsibly and thoughtfully.

Equally, Ng et al. believed that AI literacy education at secondary schools has evolved at a very fast rate, yet the discipline is still disjointed in terms of pedagogical strategies, curriculum designs and testing procedures [8]. As they reviewed, certain ones are biased towards technical knowledge, others are biased towards ethical awareness and others are biased towards practical tool use. Consequently, the definition and measurement of AI literacy in schools is yet to be agreed upon fully. This inconsistency is indicative of the fact that AI literacy is a nascent learning concept which is in need of theoretical and methodological reinforcement.

This argument is further reinforced by recent literature that is oriented towards frameworks. The OECD and European Commission AI literacy frameworks define AI literacy as a cross-curricular competence, which comprises of knowledge, skills, and attitudes required of learners to learn, interact, and critically engage with AI across primary and secondary education [9]. This framing is important as it shifts AI literacy out of technical or computing-specific education and frames it as more of a general educational objective that cuts across subjects.

It is also proposed by the literature that children and adolescents are particularly in need of AI literacy. In a systematic review of AI literacy programs in children and youth, Atias discovered that there is a wide range of educational programs with different degrees of scope and design, yet they start to focus on bridging the gap between conceptual knowledge and ethical reflection and practical use [3]. It means that the young learners should not be taught about AI literacy through teaching the definitions and

functions; instead, AI literacy should be taught to help the students comprehend the opportunities, risks, and social aspects of AI in their daily lives.

Another question that has been posed in the recent scholarship is that of pedagogy. Biagini et al. stated that AI literacy can be best cultivated through contextualized teaching experiences that are meaningful and not technical education [4]. On the same note, Feng and Carolus opined that, school learners do gain when AI literacy is associated with authentic work that involves interpretation, assessment, and responsible utilization [6]. It means that pedagogical strategies like the inquiry-based or project-based learning can be more solid grounds of AI literacy than the lecture-based or demonstration with a tool.

Simultaneously, the literature draws attention to the significant issues linked to the access, equity, and critical thinking. According to Aravantinos et al., infrastructural, teacher preparedness and disparities in the learning opportunities across school systems affect the development of AI literacy in K-12 education [2]. It implies that not only is AI literacy a curricular concern, but also a question of educational capacity and equity. People should not be allowed to use AI tools without proper guidance, as they might be provided with the instruments that may help them in the future without the necessary level of judgment to use them in a critical and ethical manner.

Put together, the literature demonstrates that nowadays, artificial intelligence literacy is accepted as a crucial educational construct, yet the conceptualization and execution of it is unequal. The current literature is in agreement that AI literacy is not only limited to the usage of the tools but also encompasses the conceptual knowledge, ethical awareness, critical understanding, and responsible use [3], [6], [8]. Nevertheless, the literature has still shown gaps due to lack of evidence in pedagogical, consistency of assessment, and integration at the school level. The gaps are the reasons why empirical studies should be conducted further on the development of AI literacy using the intervention based on the subject and organization of school students.

2.3. The Project-Based Learning in School

Project-based learning has also been widely accepted as a helpful teaching method in a school setting since it alters the mode of passive receivership of information to one of active participation in an inquiry and problem-solving. In their meta-analysis, Zhang and Ma discovered that PBL positively correlates with academic performance, affective, and higher-order thinking, demonstrating that active learning is more efficient under the conditions of student exploration and construction of knowledge based on experience instead of on memorization alone [11].

One of the benefits of PBL is that it relies on real-world problems through the use of authentic tasks that help bridge the gap between classroom learning and real-world issues and make students find knowledge more valuable. In social sciences and other scholarly topics, Duke et al. demonstrated that learning outcomes were better in project-based methods where students were relieved of individual activities, and instead they participated in context-based activities [5].

PBL also encourages teamwork, where students are more than likely to work in groups in order to discuss ideas, share responsibilities and come up with common solutions. It is a type of collaboration that promotes communication and learning among peers. Simultaneously, it promotes critical thinking, as students will have to analyze information, make decisions, solve problems, and support their conclusions. Similar findings were by Pan et al. who concluded that project-based learning enhanced creativity, motivation to learn and mastery of the subject, indicating that PBL provided a solid base to further and more thoughtful learning in school education [10].

2.4. Smart Project-Based Learning

Smart project-based learning is an integration of AI tools, project-based learning, and authentic tasks that will result in a more engaging and future-oriented learning process. Within this strategy, students not only do projects in the traditional meaning of this simple word but also employ AI-assisted tools to generate ideas, collect information, get feedback, solve problems, and create content. This integration enables the project work to be more dynamic, individualized and responsive to student needs. According to Feng and Carolus, AI literacy can be built more efficiently in context-driven and meaningful AI activities as opposed to separate technical training [6].

The rationale behind smart project-based learning is that PBL can be used to give the pedagogical framework, whereas AI can be used to improve inquiry, reflection, and productivity. Working with real-life-related problems, which require the use of AI, helps the student to explore and engage on a deeper level, and the project format fosters collaboration, creative thinking, and critical thought. According to Alfawan et al., the use of AI becomes educational when it is incorporated into a guided pedagogy instead of being applied in an unstructured manner [1]. Thus, smart project-based learning is a more dynamic, practical and future-oriented school learning model that not only prepares students to academic success but also to the realities of technology.

2.5. Social Studies Concept Learning

Acquisition of concepts in social studies is not merely one-dimensional memorization; it entails the student to learn about interrelations between concepts like society, governance, economy, citizenship, culture and geography. These ideas are highly abstract, interrelated and situation-based and this makes them hard to learn in a passive or lecture based learning. Duke et al. claimed that social studies learning is enhanced when students learn by inquiry and real-world problems situations rather than memorizing situations [5].

Active activities can enhance memorization and comprehension since they demand students to practice concepts, learn to solve problems and make links between classroom learning and their life. By discussing, engaging in project work, analyzing, and exploring in the real world, students will have a higher probability of building deeper conceptual knowledge, instead of superficially memorizing material. Similar results were obtained by Pan et al. who discovered that project-based learning in history education

enhanced knowledge mastery and motivation, which may mean that active learning makes learners internalize concepts better [10]. Thus, active and inquiry-based tasks are particularly essential in the education of social studies since they render abstract notions tangible, practical and more long-lasting.

2.6. Motivation towards Learning in Middle School Children

Motivation to learn is a very important issue in middle school education since it determines the attention, persistence, participation, and the motivation to participate in challenging tasks among the students. At this level, the students are making their academic identity and in many cases, their motivation can influence their attitude to learning, where they can either be curious or disengaged. Zhang and Ma discovered that project-based learning can have a positive impact on the affective outcomes, which indicates that motivation is enhanced when the students are involved in meaningful and engaging learning processes, as opposed to passive learning instruction [11].

Technology, autonomy and project work are of significance in enhancing motivation. Technology is able to enhance interest as learning becomes more interactive, accessible and relevant to the students in their daily experiences. Meanwhile, autonomy enables learners to choose and discover, as well as own their work, which can enhance their competence and interest. Project work also helps in motivation as it helps to relate learning to real-life tasks, cooperation and tangible results. According to Pan *et al.*, project-based learning increased the motivation to learn and the mastery of the subject matter among students, indicating that when students have a purposeful assignment they are more inclined to stay engaged in the learning and be committed to learning it [10].

2.7. Empirical Studies Review

Empirical research on this field has investigated the variables related to AI literacy, academic achievement, and learning motivation, however, in most cases independently. Ng *et al.* discovered that research into AI literacy in schools was mainly conducted on the conceptual, ethical awareness and attitude of students towards AI with most studies indicating that there was a positive change in knowledge and awareness [8]. Nevertheless, they also pointed at the shortcomings of the form of irregular definitions of AI literacy and diverse assessment procedures, which complicate the comparison of studies.

Regarding the project-based learning, Zhang and Ma have found that PBL has a positive impact on academic achievement, affective outcomes and higher-order thinking capabilities [11]. They indicate that active and inquiry-based methods can be effective to improve learning but they also revealed that their applicability is subject- and implementation-based.

Research conducted on a subject gives more insight. Project-based learning in history education was discovered to enhance students in creativity, learning motivation and subject knowledge [10] by Pan *et al.* Although these findings are encouraging, AI-supported learning was not

included in the study, so it is not applicable to technology-integrated settings.

Equally, Alfarwan *et al.* found that AI in K-12 education enhances engagement and personalized learning support, yet generates concerns over overreliance and not critically evaluating them [1]. All in all, the studies indicate positive results but indicate a major gap: few studies have investigated AI literacy, concept acquisition and motivation as one, integrated learning model.

2.8. Research Gap and Conceptual Direction

The literature review indicates that the concept of artificial intelligence in education, AI literacy, and project-based learning has become increasingly popular with scholars, yet each of them remains mostly studied independently. The current research on AI literacy primarily revolves around conceptual knowledge, ethical consciousness or attitudes towards AI, whereas the research on project-based learning has given more emphasis on academic success, motivation and higher order thinking. History and social studies that are subject specific propose that knowledge and active, inquiry-based learning may be enhanced through active and inquiry-based learning, but they seldom include AI-supported learning as a component of the learning design.

Consequently, the existing empirical data on the possibility of smart project-based learning to simultaneously develop AI literacy, understanding the concepts of social studies, and learning motivation in middle school students is scarce. The study is thus necessary to fill that gap by looking at these three outcomes within a single, integrated pedagogical framework of schools. A Conceptual Model of Smart Project-Based Learning and Learning Outcomes is shown in figure 1.

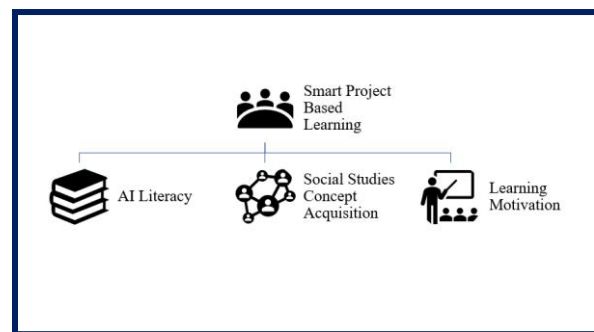


Figure 1: Conceptual Model of Smart Project-Based Learning and Learning Outcomes

3. METHODOLOGY

3.1 Research Design

The research design used in this study is quasi-experimental research design to determine the effectiveness of a smart project-based learning program in instilling artificial intelligence literacy, concepts of social studies, and motivation towards learning in middle school students. The design comprises two groups: experimental group, which will be provided with the smart project-based learning intervention, and a control group that will be instructed using traditional methods of instruction. A quasi experimental design is the right design to use since it gives the researcher

the opportunity to compare the results of two naturally occurring groups in a learning institution where complete randomization may not be feasible. This design is very common in research conducted in schools since it offers a structured means of evaluating the intervention effects on the chosen learning outcomes without disrupting the normal classroom setting. In the current research, it allows making a direct comparison between the innovative AI-based project learning and traditional teaching to find out whether the intervention contributes to a significant difference in the variables under consideration.

3.2 Participants and Sampling

The participants of the study consist of 40 middle school students in Jeddah. These students will be separated into two equal groups 20 students in experimental group and 20 students in the control group. The experimental group will undergo the smart project-based learning program and the control group will receive a normal classroom instruction. The research is carried out in an actual school setting and this makes the sample appropriate in analyzing the effectiveness of the intervention in the actual learners at the middle school level. The study can be arguably said to have used a non-probability purposive or convenience sampling method since the sample of interest is randomly selected in an existing learning environment, although the ultimate school selection method. The sampling strategy is suitable in cases of exploratory educational interventions where feasibility, access, and organization in the classroom are of significance.

3.3 Study Variables

The study is based on one independent variable and three dependent variables. The smart project-based learning program is considered to be the independent variable as it combines AI-supported tools, project-based activities, and real-life social studies activities. Dependent variables will include: artificial intelligence literacy, acquisition of social studies concepts and learning motivation. AI literacy is the knowledge, awareness and responsible use of AI tools among students in education. The concept acquisition in social studies is the understanding of basic concepts in the fields of geography, society, culture and human interaction by the students. Learning motivation is the interest, engagement and willingness of the students to engage in learning actively. These variables are chosen due to the fact that the variables represent the cognitive, technological, and affective aspects of the intervention.

3.4 Research Instruments

The study has four primary instruments to measure the impact of the intervention. The initial one is the AI Literacy Scale which is created to measure the level of knowledge of the students regarding artificial intelligence, their awareness of its use in education and their capability to utilize AI tools in a non-careless and non-incautious way. The scale will provide a witness regarding the change of AI-related knowledge and perception of students after participating in the smart project-based learning program.

The second one is the Social Studies Concepts Test which determines learning of students on important concepts in the

study of social studies. The test is not meant to test a simple factual knowledge but the skill that the students have on interpreting, relating and applying ideas to the social and geographical contexts as it is meant to test their conceptual knowledge.

The third one is Motivation Scale that assists in identifying the interest, engagement, and desire of students to get involved in the learning process. This scale will assist in determining whether the intervention has a positive impact on the level of enthusiasm of the students towards learning social studies.

The fourth resource will be a performance assessment rubric, which will be used to assess the quality of the student projects that they develop using AI tools such as ChatGPT. Accuracy of the content, creativity, teamwork, problem solving abilities, the use of AI tools, and relevance to the learning tasks in social studies are some of the criteria that can be contained in the rubric. These tools are combined to measure the technology, conceptual and motivational results of the program comprehensively.

3.5 Validity and Reliability

Validity and reliability of the research tools are significant towards credibility of the study results. The AI Literacy Scale, Social Studies Concepts Test, Motivation Scale, and performance rubric should be presented to experts in the field of educational technology, curriculum studies, and social studies education to validate the expert. Their feedback will assist in ensuring the relevance, clarity and appropriateness of the items.

Should the study be possible, it can be implemented on a pilot basis with a limited number of students the size of the real participants of the study to determine whether it has any ambiguities or practical problems. This would help in fine tuning the instruments prior to the actual research.

Internal consistency can be determined to determine reliability using measures like Cronbachs alpha, particularly on the scales that were used in the research. Adequate reliability scores would enhance belief that the instruments are able to measure the constructs intended.

3.6 Intervention Procedure

The intervention is pegged on a witty project-based learning program that integrates AI-assisted devices with real-life social studies tasks. The experimental group students are first oriented and trained in basic engineering which enables them to know how to effectively communicate with AI systems and get useful answers to their academic activities. They are then presented with the ChatGPT and other AI tools as a learning tool that can be used to aid inquiry, idea generation, content development, and problem-solving.

After this preparation, the students are involved in projects where they are asked to produce presentations, short videos, digital explanations, and simulations in the topics of social studies. These projects are structured to real-life problems to enable the students to apply the classroom concepts to real life. To illustrate, students can discuss geographical issues with the help of AI, analyze social and cultural scenarios and suggest solutions to real-life community-related problems. During the intervention, the teacher will play the role of a facilitator, showing students how to use AI responsibly,

facilitating group work, and making sure that the project work can be correlated with the goals of social studies. This process comprises the essence of the proposal as it involves the development of AI literacy, concept learning, and active engagement in one combined instructional framework.

3.7 Data Collection Procedure

The experimental and the control group should have a pre-test and post-test data collection. Prior to the commencement of the intervention, students in both groups are given the AI Literacy Scale, Social Studies Concepts Test and Motivation Scale to determine their levels at the baseline. This is followed by the implementation of the intervention with the experimental group during the intended teaching time and the control group is taught the same subject material through conventional teaching. Both groups undergo post-tests at the end of the intervention by taking the same instruments. Besides, the performance evaluation rubric is used to gather project performance data of the experimental group. It is through this process that change within groups and differences between groups can be compared following the intervention.

3.8 Statistical Analysis

Appropriate statistical methods are used to examine the collected data to establish whether the smart project-based learning program can result in significant differences in the study variables. The summary of the scores of students in AI literacy, social studies concepts and learning motivation is done first with the help of mean and standard deviation. An independent-samples t-test can be employed to compare the performance of the experimental and control groups. In case a comparison of improvements within each group (pre-test to post-test) is also a subject of the study, then paired-samples t-test can be used. Significance level can be established at 0.05 so as to establish whether differences that are being observed are significant. Effect size can also be determined to demonstrate the practical strength of the intervention not just statistical significance. These techniques are appropriate to test the effect of the program on the targeted outcomes, which can be measured.

4. RESULTS

This section introduces the results of the research based on the three independent variables: artificial intelligence literacy, social studies concept acquisition and learning motivation. The use of descriptive statistics and inferential statistics are used to report the results so as to compare the performance of the experimental and control groups prior to the intervention and after intervention. Mean scores and standard deviations are first provided to give an overview of the groups, and then independent-samples t-tests are done to compare the two groups and paired-samples t-tests to understand the improvement within the groups. The level of significance was determined as 0.05. There are also reported effect sizes to show the strength of the intervention.

4.1. Descriptive Statistics

Table 1 shows descriptive statistics of the experimental group and control group in the three variables of the study.

During the pre-test phase, the means of the two groups were very close thus showing that the two groups were similar prior to the intervention. The pre-test mean of experimental group was 11.85 (SD = 2.14), and the pre-test mean of the control group was 12.05 (SD = 2.01) as far as AI literacy is concerned. In the acquisition of the concepts of social studies, the experimental group had a pre-test mean of 12.40 (SD = 2.23), as opposed to 12.55 (SD = 2.18) in the control group. The experimental group mean of 28.10 (SD = 3.84) and the control group mean of 27.95 (SD = 3.79) were used as the mean of learning motivation.

The mean scores of all variables were significantly higher in the experimental group at the post-test stage. The mean of AI literacy after the test rose to 18.90 (SD = 2.06) as compared to 13.10 (SD = 2.12) in the control group. In the case of social studies concepts, the experimental group had a mean of 20.15 (SD = 2.34) and the control group had a mean of 14.05 (SD = 2.27). Likewise, in terms of learning motivation, the experimental group scored 38.45 (SD = 3.62) in the post-test, whereas the control group scored 30.25 (SD = 3.71). In general, the descriptive statistics give a preliminary hint that the smart project-based learning intervention resulted in superior results compared to traditional teaching.

Table 1: Descriptive Statistics of the Study Variables

Variable	Group	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD
AI Literacy	Experimental	11.85	2.14	18.90	2.06
AI Literacy	Control	12.05	2.01	13.10	2.12
Social Studies Concepts	Experimental	12.40	2.23	20.15	2.34
Social Studies Concepts	Control	12.55	2.18	14.05	2.27
Learning Motivation	Experimental	28.10	3.84	38.45	3.62
Learning Motivation	Control	27.95	3.79	30.25	3.71

4.2 Results for Artificial Intelligence Literacy

An independent-samples t -test of pre-test AI literacy scores indicated that there was no significant difference between the experimental and control groups $t(38) = -0.30, p > 0.05$. This shows that there was a statistically equal amount of the two groups prior to the intervention. But at the post-test level, the difference between the two groups became significant $t(38) = 8.77, p < 0.001$, and the size of the effect is great (Cohen $d = 2.77$). The mean score of the experimental group ($M = 18.90, SD = 2.06$) was much higher than that of the control group ($M = 13.10, SD = 2.12$).

The paired samples t-test of the experimental group revealed significant difference in the AI literacy between pre-test and post-test, $t(19) = 16.77, p < 0.001$, which means that there was a significant improvement in the AI literacy following the intervention. A minor increase was also observed in the control group but the difference was significantly less, $t(19) = 2.88, p < 0.05$. Such findings imply that the smart project-based learning course had a significant impact on the AI literacy of students in enhancing their knowledge, awareness,

and practical application of AI-enabled tools. Table 2 shows Comparison of AI Literacy Scores.

Table 2: Comparison of AI Literacy Scores

Comparison	Mean	SD	t-value	p-value	Effect Size
Experimental Pre-test	11.85	2.14			
Control Pre-test	12.05	2.01	-0.30	0.762	0.10
Experimental Post-test	18.90	2.06			
Control Post-test	13.10	2.12	8.77	0.000	2.77

4.2. Findings of Social Studies Concept Acquisition

To acquire concepts on social studies, the independent-samples t-test revealed that there was no significant difference between the two groups at pre-test $t(38) = -0.22, p > 0.05$ indicating the two groups were equivalent before the intervention. However, at the post-test stage, the experimental group significantly exceeded the control group, $t(38) = 8.37, p < 0.001$, and the effect size (Cohen d) is large (2.65). The mean score of experimental group on the post-test was 20.15 (SD = 2.34) and the control group on the post-test was 14.05 (SD = 2.27).

The paired samples t-test of the experimental group indicated that there was a significant difference between pre-test and post-test, $t(19) = 16.43, p < 0.001$. Control group also had a slight improvement $t(19) = 3.90, p < 0.01$, however, the amount of change was much smaller. These results indicate that the students taught using smart project-based learning could comprehend, relate, and implement the essence of social studies more than those taught using traditional instructions. Comparison of Social Studies Concept Scores is shown in table 3.

Table 3: Comparison of Social Studies Concept Scores

Comparison	Mean	SD	t-value	p-value	Effect Size
Experimental Pre-test	12.40	2.23			
Control Pre-test	12.55	2.18	-0.22	0.831	0.07
Experimental Post-test	20.15	2.34			
Control Post-test	14.05	2.27	8.37	0.000	2.65

4.3. Learning Motivation Results

Comparison of pre-test on learning motivation showed that there was no significant difference between experimental and control group $t(38) = 0.12, p > 0.05$, and this implies that there was similar motivational baseline. The post-test comparison revealed that the difference between experimental and control groups was statistically significant ($t(38) = 7.07, p < 0.001$) with a significant effect size (Cohen D = 2.24). The experimental group had a post-test mean of 38.45 (SD = 3.62) compared to the control group that had 30.25 (SD = 3.71).

The paired-samples t-test also indicated that there was a significant difference in motivation of the experimental group between pre-test and post-test, $t(19) = 15.64, p < 0.001$. There was also a moderate increase in the control group $t(19) = 4.27, p < 0.01$, but it was obviously smaller than in the experimental group. These results suggest that the intervention did not only enhance cognitive and technological performance but also students were more interested, more participating, and more willing to take part in the learning activities. Comparison of Learning Motivation Scores is shown in table 4.

Table 4: Comparison of Learning Motivation Scores

Comparison	Mean	SD	t-value	p-value	Effect Size
Experimental Pre-test	28.10	3.84			
Control Pre-test	27.95	3.79	0.12	0.902	0.04
Experimental Post-test	38.45	3.62			
Control Post-test	30.25	3.71	7.07	0.000	2.24

4.4 Overview of general findings

In general, the outcomes were always in favor of the experimental group in all the three dependent variables. The descriptive statistics provided significantly increased means of post-test in the experimental group in terms of AI literacy, acquisition of social studies concepts, and motivation to learn. The comparisons made in the pre-test confirmed that the groups were comparatively equal prior to the intervention, but the comparisons made in the post-test showed that there are significant differences in favor of the experimental group in all variables. Moreover, the within-group paired-samples t-tests indicated that the experimental group had significantly improved compared to the control group with the course of time.

The findings offer a solid empirical evidence of the success of smart project-based learning program. Students engaged in AI-based project-based learning acquired greater AI literacy, learned more concepts of social studies, and showed more motivation to learn as compared to students who underwent traditional learning. The trend that was followed shows that there was a significant and positive effect of the intervention on cognitive and affective levels of learning. Summary of Hypothesis Testing is shown in table 5.

Table 5: Summary of Hypothesis Testing

Hypothesis	Variable	Test Used	Result	Decision
H1	AI Literacy	Independent t t-test (Post-test)	Significant t at $p < 0.001$	Accepted
H2	Social Studies Concept Acquisition	Independent t t-test (Post-test)	Significant t at $p < 0.001$	Accepted
H3	Learning Motivation	Independent t t-test (Post-test)	Significant t at $p < 0.001$	Accepted

5. DISCUSSION

This part will explain the findings in terms of the objectives of the study and the existing literature. Altogether, the findings suggest that the smart project-based learning (Smart PBL) intervention influenced the AI literacy, social studies concept acquisition and learning motivation among middle school students in a positive and significant way. These results are discussed below in terms of their connection to instructional design of the intervention and the existing educational theory.

5.1. AI Literacy Findings Discussion

The strong shift in the level of AI literacy of students in the experimental group may be attributed to the fact that active, guided, and contextualized work with AI tools, which are integrated into the Smart PBL approach, is conducted. In contrast to a traditional teaching process, AI can be talked about in theory, students of the intervention group directly employed AI tools to generate ideas, get answers, and create project outputs. This practical application probably advanced their functional knowledge of AI, past theoretical knowledge to practical competence.

Guided practice was also an essential role. The students were introduced to prompt engineering and assisted by the teacher to effectively use AI tools. Such a hierarchical approach decreased the abuse and the students were made aware of not just how to use AI, but when and why to use it. The scaffolding of this nature is necessary to create meaningful AI literacy, especially in the middle school.

Also, the exposure to AI tools repeatedly enhanced the familiarity with the tools, which probably decreased hesitation and developed confidence. Students felt more at ease with AI systems and understanding outputs. Understanding was also enhanced by including real-life engagement where AI was applied to solve real-life problems or subject-related problems. This is in line with the fact that AI literacy is best developed through practical applications and not in isolated settings. Comprehensively, the results indicate that Smart PBL provides a supportive environment to cultivate AI literacy via practice, reflection and meaningful use.

5.2. Findings of Social Studies Concepts Discussion

The enhancement of the concept acquisition of social studies could be explained by the manner, in which Smart PBL promotes the deep, active, and contextual learning. Conventional instruction tends to focus on memorizing, and the intervention involved the students to use concepts in project work. This active application having been made out of passive reception might have contributed to internalizing of complex ideas on the part of the students about the society, geography and human interaction.

Visualization and explanation were also facilitated by using AI tools to allow students to learn concepts using several different formats, including summaries, examples, and organized descriptions. This multimodal interaction could have provided access to abstract ideas and their comprehension. In addition, project assignments involved students to analyze information, compare points of view and produce solutions, which are the main processes of conceptual learning.

Real life relevance is another factor that is important. The projects were structured with real world problems and the students would be able to relate what they have learned in the classroom with the real world. This probably boosted the learning and memorization, since the students were able to observe the practicality of what they were being taught. The results indicate that Smart PBL provides not only a better conceptual knowledge but also changes the way students interact with the content of subjects, making the learning process more meaningful and sustainable.

5.3. Motivation Results Discussion

Various characteristics of the Smart PBL environment can be attributed to the rise in the motivation to learn in the students in the experimental group. To start with, the strategy encourages independence, since students are provided with chances to make decisions, develop ideas and own their learning activities. Such a feeling of control has been known to promote intrinsic motivation and engagement.

Second, there was a feeling of novelty brought about by the implementation of AI tools. With the emerging technologies like ChatGPT, it is possible that the learning process was more enjoyable and interactive than the more traditional classroom approach. Innovative learning spaces tend to provoke curiosity and allow paying attention to a long time.

Third, the intervention was relevant with the projects tasks being related to real-world problems and meaningful contexts. Students will have more chances to invest efforts and stay engaged in learning when they find it useful and applicable. Lastly, project-based learning was collaborative, which facilitated participation, with students operating in groups, exchanging ideas, and pursuing a common objective. This interpersonal communication has the potential to boost motivation by creating a sense of belonging and being responsible together.

A combination of these factors developed an interesting and interactive learning atmosphere that facilitated cognitive and affective growth. The results suggest that Smart PBL can be an effective way to boost the motivation of students with a combination of autonomy, innovation, and meaningful participation.

5.4. Comparison to the Past Studies

The results of this paper are mostly in line with the existing literature in the areas of AI in education and project-based learning. The fact that AI literacy has improved corresponds with the research that has focused on the need to contextualize and apply AI tools when building technological knowledge. Equally, the beneficial effect of positive influence on social studies concept acquisition agrees with previous studies that demonstrate project-based learning and inquiry-based learning to be effective at conceptual learning.

The rise in the motivation to learn is also in line with previous research findings that active learning, autonomy, and relevance in the real world enhance student engagement. Nevertheless, the paper is not similar to most of the past research since it combines AI-driven tools into a project-based learning model instead of considering these aspects individually. Although previous research has tended to concentrate on either AI literacy or outcomes of project-

based learning, this research paper reveals that the two methodologies can yield concomitant gains in the cognitive, technological, and motivational realms.

It is an important addition to the literature because of this integrated approach. It offers an empirical data that Smart PBL can be not only useful in remote regions but also a comprehensive teaching model that can help to fulfill several learning outcomes in a single intervention.

5.5. Educational Implications

The results carry significant implications to the classroom instruction, curriculum and the policy of AI integration. To apply to classroom instruction, the findings indicate that the incorporation of smart project-based learning can have a beneficial effect on cognitive and motivational outcomes by encouraging active learning, collaboration, and significant application of AI tools. Educators must be urged not only to stop using conventional teaching methods but also to use guided and technology-based pedagogies that will help students not only to acquire knowledge in specific subjects but also to enhance their level of digital literacy.

Regarding the curriculum design, the research indicates that it is necessary to incorporate AI literacy and project-based activities into the subject fields, in which they are not viewed as individual units. This integration will be able to assist in more in-depth learning and practical application of concepts.

On the policy level, the results highlight the significance of systematic AI implementation in schools, such as teacher education, usage of AI devices, and precise instructions on responsible usage. The policies in education need to enable the creation of AI-ready students by matching the use of technology with the objectives of education.

6. CONCLUSION

This research was carried out to research the efficacy of smart project-based learning in improving the artificial intelligence literacy, social studies concept learning as well as learning motivation in middle school students. The aim of the research was to find out whether the combination of AI-assisted tools with project-based learning and real-life classroom activities could yield better educational results as compared to traditional teaching strategies. The study thus fills a significant gap in the literature by targeting the middle school learners in a social studies setting, where the learning of AI, the learning of the subjects, and motivation are usually considered separately and not as a single integrated teaching model.

The results indicated that the smart project-based learning intervention had positive effects on all the three dependent variables. Students in the experimental group also exhibited a better AI literacy, better conceptualization of social studies and greater levels of learning motivation than students in the control group. These findings suggest that with the implementation of AI tools as part of the guided project work, students tend to be more active in content consumption, meaningful application of ideas, and grow both technologically and academically competent. The intervention also demonstrated that project-based pedagogy with the support of relevant digital tools makes learning more interactive, relevant and student-centered.

These findings are important as they contribute to theory and practice. The paper contributes to the developing body of work dedicated to AI in education by demonstrating that AI-mediated learning is most successful in the case of pedagogically scaffolded and realistic learning activities. It further reinforces the thesis that project-based learning can be an effective model of introducing AI into the school curriculum in a manner that not only allows students to learn the material but also develops their digital literacy and interest in learning.

In the case of middle school education, the research is especially significant since this age is a critical phase to develop conceptual knowledge, academic curiosity and competencies related to the future. The results are that smart project-based learning has the potential to assist schools not only in preparing students to do well academically in the short term but also to be ready to be part of a technology-saturated world. Thus, the paper concludes that smart project-based learning is a good and useful educational method in the modern middle school.

7. RECOMMENDATIONS

In accordance with the results of the research, a number of recommendations are given regarding the future research and educational practice. To start with, the same studies need to be done using larger sample sizes to enhance the generalizability of the results, and offer more evidence in various school settings. A more significant sample would also enable more statistical comparison and conclusions that are more reliable.

Second, the researchers ought to take into account longer interventions in the future. The current research shows that smart project-based learning is worthy but a longer duration can give more information about the development of AI literacy, conceptual knowledge, and motivation as time goes by.

Third, the strategy must be experimented on other subject domains like science, mathematics, language learning and history so as to find out whether smart project-based learning also has the same benefits as social studies. This would assist it in determining its broader educational applicability.

Fourth, educational institutions and schools should offer teacher education on the AI-based project pedagogy. Teachers should be trained in a systematic way in prompt engineering, responsible use of AI, and project facilitation to enable them to lead students successfully in learning environments that are rich in technology.

Lastly, AI literacy should be integrated into the curriculum on a curriculum-wide level. Instead of considering AI as a subject or object that cannot be integrated into other school subjects, curriculum planners ought to incorporate AI literacy in all school subjects to help students acquire knowledge, skills, and attitudes vital in responsible engagement in a digitally advanced society.

8. LIMITATIONS

Although the study has had its contributions, it has a number of limitations that must be noted. First, the sample size of 40 students is too small that the results cannot be extended to other population. Second, the research was carried out in one

city (Jeddah) and therefore, the findings might be affected by local educational situations and might not be a complete picture of other areas and settings. Third, the intervention was also comparatively short in time, which might not reflect any long-term interventions of smart project-based learning on AI literacy, conceptual understanding, and motivation. It would be interesting to have a longer implementation period to get more information about sustained learning outcomes.

Lastly, it is possible that there were restrictions in the access to AI tools and technological resources, which may affect the regularity of student engagement and performance. The results might have also been subject to differences in the familiarity with technology among the students. The interpretation of the findings and future studies should take into account these limitations.

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