

The Impact of Integrating an Intelligent Personal Assistant (IPA) on Secondary School Physics Students' Scientific Inquiry Skills

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Abstract— Intelligent Personal Assistants (IPAs) carry massive potential in enhancing students' performance through individualized dynamic scaffolding strategy. Despite IPAs being increasingly recognized among educationists, little is known about its application on the development of students' scientific inquiry skills, particularly in Physics. This study integrated the use of Apple's Siri in physics learning and examined the impact on secondary school students' scientific inquiry skills, and how these interactions affect their learning experiences. This mixed-method study conducted two field quasi-experiments (School A: Science boarding school, School B: Vocational boarding school) and post-experimental focus group discussions. Each school had two classes that were randomly assigned as experimental and control groups. The quantitative data showed that the experimental groups developed significantly higher scientific inquiry skills in comparison to the control groups (School A: $p = 0.050$, School B: $p < 0.001$) with moderate ($d = 0.62$) to large effect size ($d = 1.82$). The qualitative data further revealed the perceived ability of the IPA to support students' individualized learning by providing timely scaffolding. This study offers substantial empirical data to support the effectiveness of the IPA in increasing secondary school students' achievement in physics and scientific inquiry skills.

Index Terms—Intelligent Personal Assistant (IPA), individualized dynamic scaffolding, scientific inquiry skills, secondary school physics learning

I. INTRODUCTION

TODAY, more important than ever, educators carry immense responsibility to prepare a highly competent workforce that is capable of making informed decision and action based on critical analysis of scientific-based information. By driving revolutionary innovation and building competitive advantage in a global economy, a focus on nurturing scientific inquiry in addition to attaining academic achievement is central in any education plan or policy. At the same time, educators face constant challenges in catching new waves of technological advancement and riding them to diversify the existing pedagogical practices. In this context, there is an urgent need to

integrate easily available and user-friendly technology to help educators develop scientific inquiry skills among students.

Based on the National Science Education Standards [1], scientific inquiry describes the various methods by which scientists investigate the natural world and develop understandings following the facts gained. Basic principles governing well-grounded scientific inquiry involves hands-on researching activities, objectivity as well as rigorous thinking and most importantly, it undertakes a systematic investigation approach. Primarily, scientific inquiry entails more than just 'doing experiments' as it necessitates a high level of imagination and inventiveness [2]. However, in order to leverage this concept at a level appropriate for secondary schools, fundamental scientific inquiry skills are outlined as follows: (a) identify a problem, (b) devise a hypothesis, (c) plan procedures, (d) carry out a scientific experiment, (e) gather, organize and interpret data, (f) employ statistical techniques to support conclusions, and (g) report findings [3], [4].

A point to note, scientific inquiry varies significantly in the amount of freedom and autonomy given to the students. For this reason, scientific inquiry can be categorized into three main approaches, namely (a) structured scientific inquiry; where students conduct the investigation process according to prescribed procedure, (b) guided scientific inquiry; where students investigate collaboratively with teachers, and (c) open inquiry; where students take responsibility and ownership to independently design the investigation procedures [5], [6]. The first two approaches place great emphasis on external forms of assistance, while the third approach views students as the key figure to direct their own learning, resonating the valuable virtue of competent learners with high scientific inquiry skills.

In the world of mobile devices, intelligent personal assistants (IPAs) gain strong recognition due to its potential in supporting students' learning. By combining artificial intelligence in its design, IPAs are able to perform user commands and provide communication or interaction. Voice-controlled IPAs such as Amazon's Alexa, Samsung's S Voice and Apple's Siri can be

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Table of Contents The Personal Assistant Advanced Secondary Students Manual

1. Understanding the eBook The Personal Assistant Advanced Secondary Students Manual
 - The Rise of Digital Reading The Personal Assistant Advanced Secondary Students Manual
 - Advantages of eBooks Over Traditional Books
2. Identifying The Personal Assistant Advanced Secondary Students Manual
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an The Personal Assistant Advanced Secondary Students Manual
 - User-Friendly Interface
4. Exploring eBook Recommendations from The Personal Assistant Advanced Secondary Students Manual
 - Personalized Recommendations
 - The Personal Assistant Advanced Secondary Students Manual User Reviews and Ratings
 - The Personal Assistant Advanced Secondary Students Manual and Bestseller Lists
5. Accessing The Personal Assistant Advanced Secondary Students Manual Free and Paid eBooks
 - The Personal Assistant Advanced Secondary Students Manual Public Domain eBooks
 - The Personal Assistant Advanced Secondary Students Manual eBook Subscription Services
 - The Personal Assistant Advanced Secondary Students Manual Budget-Friendly Options
6. Navigating The Personal Assistant Advanced Secondary Students Manual eBook Formats

- ePub, PDF, MOBI, and More
 - The Personal Assistant Advanced Secondary Students Manual Compatibility with Devices
 - The Personal Assistant Advanced Secondary Students Manual Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of The Personal Assistant Advanced Secondary Students Manual
 - Highlighting and Note-Taking The Personal Assistant Advanced Secondary Students Manual
 - Interactive Elements The Personal Assistant Advanced Secondary Students Manual
 8. Staying Engaged with The Personal Assistant Advanced Secondary Students Manual
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers The Personal Assistant Advanced Secondary Students Manual
 9. Balancing eBooks and Physical Books The Personal Assistant Advanced Secondary Students Manual
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection The Personal Assistant Advanced Secondary Students Manual
 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
 11. Cultivating a Reading Routine The Personal Assistant Advanced Secondary Students Manual
 - Setting Reading Goals The Personal Assistant Advanced Secondary Students Manual
 - Carving Out Dedicated Reading Time
 12. Sourcing Reliable Information of The Personal Assistant Advanced Secondary Students Manual
 - Fact-Checking eBook Content of The Personal Assistant Advanced Secondary Students Manual
 - Distinguishing Credible Sources
 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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