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Brilliant resource integration for gifted and high talent: a career optimization system for gifted students

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ABSTRACT

Brilliant resource integration for gifted and high talent (BRIGHT) was developed as a technology-based educational management system to help schools identify the potential of gifted and talented students (GTS) and translate it into personalized talent-development and career recommendations. This study employed a research and development (R&D) design using the analysis, design, development, implementation, and evaluation (ADDIE) model and evaluated the system with 392 senior high school students from Central Java, the Special Region of Yogyakarta, and East Java. BRIGHT integrates student-profile assessment with an analytical hierarchy process (AHP)-based decision mechanism to support more objective potential mapping and career planning. The results show that most students were classified in the moderate-to-high categories across all assessed dimensions. Career readiness and planning recorded the highest proportion in the high category (52.0%), followed by career interest (46.2%), learning style and work environment fit (45.7%), and career personality (45.4%). Spearman's rho analysis also confirmed significant positive relationships between BRIGHT outputs and all career-development dimensions, with coefficients ranging from 0.672 to 0.762 ($p<0.001$). These findings indicate that BRIGHT is effective in supporting potential identification, learning-environment alignment, and career readiness among gifted students. The novelty of this study lies in the integration of gifted-student identification, personalized development planning, and data-driven career recommendation within a single school-based educational management system.

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1. INTRODUCTION

Gifted and talented students (GTS), often referred to as gifted learners, are individuals who demonstrate significantly above-average intellectual ability and exceptional cognitive potential compared with their peers. They are frequently able to complete complex tasks more rapidly, effectively, and systematically, and may show more advanced physical and psychological development [1]. In the Indonesian context, this group is closely associated with students with special intelligence and special talents, commonly referred to as *cerdas istimewa dan bakat istimewa* (CIBI), whose abilities may appear in domains such as the arts, sports, science, technology, and leadership. Renzulli [2] three-ring conception explains giftedness

through three interrelated characteristics, namely above-average ability, creativity, and strong task commitment. Although these students possess notable strengths, they are also learners with special educational needs because their potential requires differentiated instruction, enriched or accelerated curricula, and educational services that are responsive to their rapid learning pace, curiosity, creativity, and openness to new ideas and technologies [3], [4].

The development of GTS cannot be understood solely from a cognitive perspective because their intellectual strengths are often accompanied by distinctive psychosocial characteristics. Gifted students may experience perfectionism, heightened sensitivity, anxiety, boredom in conventional classrooms, and social isolation, making early identification and appropriate enrichment or acceleration programs essential for balancing intellectual growth and emotional well-being [5]. Family and school environments also play important roles in supporting their development. Parenting patterns during childhood and adolescence influence students' character, independence, and long-term developmental outcomes, while the school environment provides opportunities for students to adapt, maintain individuality, and develop their potential through meaningful educational experiences [1]. When adequate support is absent, gifted students may experience emotional and social imbalance. Zhu *et al.* [4] found that positive parenting and supportive relationships within schools were associated with stronger character attributes among Chinese adolescents. Their findings highlight the importance of parental support, constructive parent–child relationships, and positive interactions with teachers and peers in adolescents' character development [6]. Emotional intelligence is therefore important because it is associated with lower engagement in risky behaviors and stronger prosocial behavior among adolescents [7]. Moreover, if gifted potential in science, technology, the arts, and leadership is not systematically nurtured, it may be misdirected toward harmful outcomes, including illegal activities, cybercrime, or radicalization [8]. Effective parenting and educational support are consequently necessary to promote cognitive growth, emotional stability, social adaptability, independence, and future autonomy [9], [10].

These issues have direct implications for educational management and career development. As shown in Figure 1, the projected increase in cybercrime losses indicates that advanced technological ability may create broader societal risks when it is not guided by ethical, constructive, and well-directed educational support. In addition, Figure 2 presents Indonesia's open unemployment rate by gender and residential area from August 2021 to August 2024, showing that employment access and career alignment remain important concerns despite the general declining trend. Data from BPS-Statistics Indonesia indicate that the open unemployment rate in August 2024 was 4.91%, representing a decrease of 0.41 percentage points compared with August 2023 [11]. Although this figure reflects a declining trend, it still indicates that employment access and career alignment remain important issues. For GTS, this issue is not limited to access to work, but also concerns the accuracy with which their abilities, interests, learning styles, personality characteristics, and career readiness are aligned with meaningful educational and occupational pathways. Therefore, schools require a technology-based educational management system that can identify giftedness more objectively, guide talent development more systematically, and generate personalized career recommendations. In this study, Figure 2 is used as contextual evidence of the broader relevance of career-readiness and person–career fit issues rather than as a direct measurement of individual career mismatch. This context strengthens the rationale for developing the brilliant resource integration for gifted and high talent (BRIGHT) system, which supports accurate potential mapping, career-readiness assessment, and personalized career recommendation for GTS.

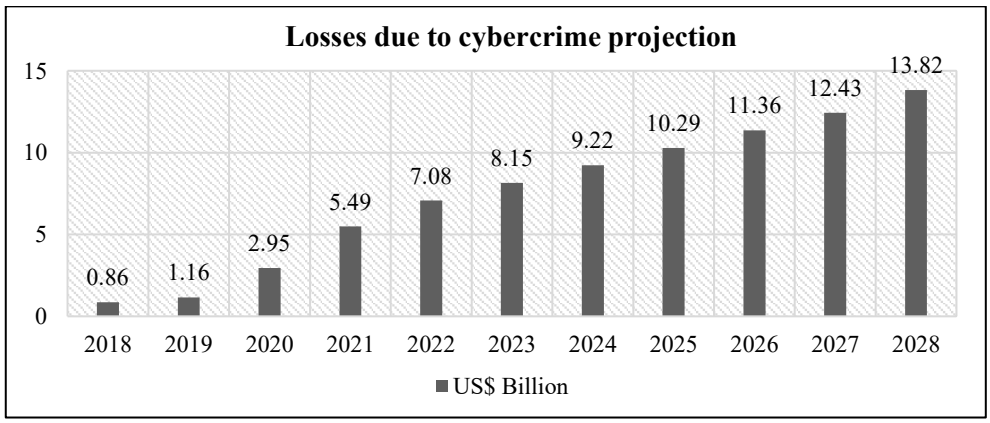

Figure 1. Losses due to cybercrime projection

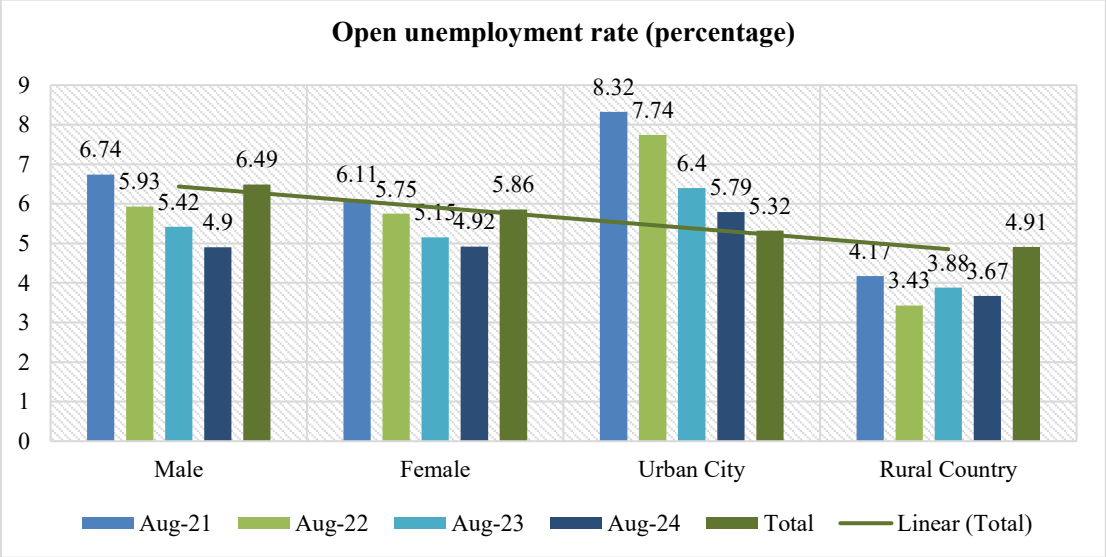

Figure 2. Open unemployment rate by gender and residential area (August 2021–August 2024)

Previous studies have contributed valuable insights into the psychological, educational, and social characteristics of gifted students. However, the existing literature remains fragmented. Psychological studies have emphasized parenting, character development, emotional imbalance, and social adaptation; educational studies have highlighted differentiated instruction, enrichment, and acceleration; and technology-related studies have discussed digital tools or learning applications [12]. What remains insufficiently addressed is an integrated technology-based system that connects potential identification, talent development, socio-emotional consideration, personalized learning support, progress monitoring, and career mapping within one coherent educational management framework. This research gap is particularly important because conventional approaches often rely on partial assessment and subjective judgment, while schools require a structured and data-driven mechanism to support decision-making for gifted students. To address this gap, the present study proposes BRIGHT as a technology-based educational management system designed to integrate the identification of gifted students' potential, personalized talent-development planning, and career recommendations within a single platform.

The BRIGHT system integrates the analytical hierarchy process (AHP) as part of a decision support system (DSS) to strengthen decision-making in the selection and development of gifted students. AHP enables multi-criteria evaluation by considering academic achievement, non-academic skills, individual interests, and recommendations from educators, thereby improving the objectivity and accuracy of student selection and potential mapping [13]. This approach is relevant because gifted students can contribute substantially to technological innovation, economic growth, scientific advancement, academic quality, and leadership when their potential is guided toward appropriate career pathways. This approach is relevant because structured gifted education can help transform high potential into productive talent, creative output, and appropriate career development [2], [14], [15]. In the fields of education and research, gifted students' high curiosity and academic capability may support the production of knowledge, while academic achievement reflects changes in knowledge, comprehension, application, analytical ability, synthesis, and evaluation [5]. Nevertheless, empirical evidence indicates that gifted students may experience imbalance between intellectual optimization and psychosocial development [16], [17]. Therefore, cognitive development must be accompanied by socio-emotional support, as gifted individuals with strong emotional intelligence may become agents of positive social and cultural change [6].

Accordingly, this study aims to develop and evaluate the BRIGHT system as a comprehensive educational management system for GTS. Specifically, the study seeks to design a technology-integrated model for identifying, developing, and monitoring gifted students; develop key system features such as talent mapping, personalized learning recommendations, student progress monitoring, and career guidance; evaluate the effectiveness of BRIGHT in improving the accuracy of potential mapping and talent development compared with conventional approaches; and analyze the challenges and opportunities of implementing the system across educational institutions. Through this focus, the study is expected to contribute a more structured, needs-based, and data-driven framework for managing gifted education and supporting sustainable career optimization for GTS.

2. LITERATURE REVIEW

2.1. Gifted and talented students: concept and psychosocial profile

GTS, often referred to as gifted learners, are individuals who demonstrate significantly above-average intellectual abilities. They possess exceptional cognitive potential and frequently exhibit more advanced physical and psychological development compared to their peers. These students are capable of completing complex tasks more rapidly, effectively, and systematically than other learners. The concept is often associated with special talents CIBI, which refer to outstanding abilities in specific domains such as the arts, sports, or leadership. According to Renzulli [2] three-ring conception, gifted individuals are characterized by three core attributes: above-average ability, high creativity, and strong task commitment. Giftedness should therefore be understood as a multidimensional construct that may appear not only in analytical or academic domains, but also in creative, artistic, interpersonal, leadership, technological, and practical domains.

Despite their advantages, gifted students are categorized as learners with special educational needs, as they require differentiated instruction, specialized curricula, and tailored educational services to fully develop their potential. Students with CIBI characteristics often require accelerated or enriched curricula to prevent underachievement due to boredom in conventional classroom environments. They typically demonstrate rapid learning capacity, high levels of curiosity, and strong creativity and task commitment compared to their peers. To support the development of these strengths, enrichment pedagogy offers learning opportunities aligned with students' interests and abilities, incorporating differentiated instruction, independent investigation, and creative problem solving to encourage talent development and creative productivity [14].

From a psychosocial perspective, gifted students exhibit distinctive characteristics. While they possess highly advanced cognitive abilities, strong curiosity, and exceptional creativity, they are also prone to perfectionism, heightened sensitivity, and anxiety. They frequently experience boredom in regular classrooms and may face social isolation, necessitating specialized interventions such as enrichment and acceleration programs to address the imbalance between their intellectual and emotional development. Early identification of these characteristics by both parents and educational institutions is essential to ensure that their potential is optimally nurtured without compromising their mental well-being [18].

Parenting styles play a critical role in children's growth and development, particularly during the formative years between ages 3 and 17. Appropriate parenting practices contribute positively to children's development and independence, whereas inadequate parenting approaches may negatively affect their developmental outcomes and future autonomy. In addition, the development of students' potential requires the ability to adapt to their school environment; however, adaptation should not imply conformity, but rather a balanced process that allows students to maintain their individuality while engaging effectively with their surroundings. Gifted students possess exceptional potential across various domains, including science, technology, the arts, and leadership. However, without appropriate educational and psychosocial support, this potential may be accompanied by underachievement, social isolation, emotional pressure, and adjustment difficulties [16], [17]. Therefore, the management of gifted students should integrate academic enrichment with psychosocial support from families, teachers, and school leaders [14], [17]. These findings indicate that gifted education should not focus solely on cognitive acceleration, but should also provide counselling support, socio-emotional development, mentoring, and a school environment that can accommodate the distinctive characteristics of gifted learners.

Emotional and social imbalances also represent significant challenges for gifted students who lack appropriate support. Many gifted students may experience difficulties in adapting to their social environments, which can lead to feelings of isolation and heightened psychological pressure [16], [17]. Emotional intelligence is therefore important because it is positively related to prosocial behavior and supports adolescents' ability to interact constructively with others [19]. These findings highlight the importance of socio-emotional development alongside cognitive advancement, particularly for gifted students whose intellectual development may not always be balanced with emotional and social maturity. In this context, parenting once again emerges as a crucial factor influencing children's development. Appropriate parenting practices foster independence and positive developmental outcomes, whereas inadequate parenting may hinder children's growth and negatively impact their future trajectories [20].

2.2. Talent and interest: theoretical foundations and their relationship with future awareness

Talent refers to an individual's innate potential present from birth. It encompasses natural abilities, aptitudes, and inherent capacities that enable a person to acquire specific skills more quickly and effectively than others. As a foundational potential, talent requires consistent training and development to be transformed into outstanding achievement. Individuals with strong talent are able to learn within a relatively shorter time frame while often producing superior outcomes [21]. Talent is often regarded as a unique

endowment that varies across individuals and serves to enrich society and support human roles and contributions. While talent facilitates learning and performance in specific domains, achieving excellence still requires sustained effort and practice [22].

In contrast, interest differs conceptually from talent. Talent represents an inherent capacity that must be cultivated through education and training, whereas interest reflects an affective inclination toward particular activities that develops over time alongside an individual's physical and psychological growth. Interest refers to what individuals enjoy and are motivated to pursue, while talent represents their natural ability to excel in a given domain. It is possible for individuals to be interested in areas where they lack strong talent, and conversely, to possess talent in areas that do not align with their interests [23]. Interest can be understood as a strong internal drive characterized by enthusiasm, curiosity, and sustained attention toward specific activities. It functions as a psychological motivator that encourages individuals to engage in learning or performing tasks voluntarily. Unlike talent, interest is dynamic and evolves through experience, environmental influences, and age [24].

The integration of talent and interest plays a critical role in maximizing individual potential. Talent provides the foundation for achievement, while interest serves as the driving force of motivation. When these two elements are aligned and supported by consistent practice, individuals are more likely to achieve optimal performance and develop competitive advantages. The intersection between talent and interest is therefore essential in determining appropriate educational pathways and career choices, enabling individuals to achieve greater productivity and personal fulfillment. Furthermore, awareness of one's future, grounded in an understanding of personal talent and interest, represents a form of career planning based on self-awareness. This process involves recognizing internal attributes—including natural abilities, preferences, values, and personality traits—to determine appropriate career directions and life goals. For GTS, future awareness extends beyond conventional aspirations; it represents a complex cognitive and emotional capacity to envision and evaluate future possibilities in a more advanced and comprehensive manner compared to their peers [18]. This understanding is consistent with Gagné [15] differentiated model of giftedness and talent, which distinguishes natural abilities or gifts from systematically developed talents. From this perspective, gifted potential requires structured developmental catalysts, including educational support, motivation, environment, mentoring, and appropriate career guidance, in order to be transformed into mature talent [15].

2.3. Personality intervention through artificial intelligence innovation

Understanding talent and interest enables individuals to select career paths aligned with their competencies, thereby increasing the likelihood of job satisfaction and productivity. The integration of inherent potential (talent) and personal preference (interest) contributes to optimal performance outcomes. High levels of self-awareness allow individuals to make more accurate life and career decisions, rather than merely following external trends. This process extends beyond employment acquisition, encompassing strategic self-development through training, certification, and relevant experiences to achieve desired future outcomes [25]. Personality intervention in this study refers to a structured set of psychological strategies, techniques, and therapeutic approaches designed to modify maladaptive patterns of thinking, behavior, and emotion into more adaptive and constructive forms. Typically conducted by mental health professionals, such interventions aim to enhance social functioning and promote individual well-being, particularly in the context of career development and future planning.

In this research, personality intervention is enhanced through technological innovation, specifically through the use of modern digital tools such as mobile applications, artificial intelligence (AI), virtual reality (VR), and wearable devices. These technologies enable systematic monitoring, analysis, and exploration of individual personality traits and behavioral patterns. This approach represents an integration of psychology and computer science—often referred to as digital psychology—with the objective of facilitating intentional character development. For instance, such interventions may aim to improve traits such as conscientiousness, self-regulation, and self-awareness, which are essential for long-term personal and career success.

2.4. Design of research intervention in educational settings

Education for GTS constitutes a critical component of the educational system that must be managed through specialized approaches to optimize their potential. Gifted students require differentiated educational approaches because their development is characterized by above-average ability, creativity, task commitment, advanced learning needs, and diverse talent-development trajectories [2], [14]. Studies in the Indonesian context also indicate that the uniqueness of gifted children is still often perceived as learning or behavioral problems by teachers and peers, demonstrating the need for comprehensive academic and non-academic support from teachers and school leaders [17]. Recent research on adaptive learning models further emphasizes that gifted education should integrate global frameworks with local contexts and implementation challenges [26]. These findings strengthen the need for an adaptive and targeted educational

management system that can support gifted-student identification, talent development, progress monitoring, and career mapping in a more systematic manner.

Education is also expected to enhance the overall quality of human resources, thereby contributing to the advancement of science and technology. In this context, the rapid development of information technology has created new opportunities in education, particularly in the management and development of gifted learners. The integration of technology into educational systems has the potential to improve learning effectiveness and provide more adaptive and personalized learning experiences [1], [26]. Based on this context, there is a clear need for innovation in educational management systems that can effectively accommodate the unique needs of GTS. Standard school management systems are generally designed to manage administrative and academic records, such as attendance, grades, schedules, and enrollment data. However, such systems are insufficient for gifted education because they do not interpret the non-linear developmental patterns of gifted students, including asynchronous development, creative potential, socio-emotional vulnerability, learning-environment fit, and career-readiness trajectories.

2.5. State of the art and research gap

Existing studies address gifted-student characteristics, parenting, counseling, learning achievement, or educational technology separately; however, they do not provide an integrated automated identification-to-career system that links psychological profiling, talent mapping, personalized development planning, and professional career recommendation. The state of the art and research gap of previous studies are summarized in Table 1.

Table 1. State of the art and research gap of previous studies

Study	Findings	Research gap
[1]	The study identifies key indicators of career success among GTS.	This qualitative study focuses on identifying career success indicators; however, it does not incorporate technological solutions to support career mapping.
[3]	The findings indicate a significant influence of parenting styles on character development among junior high school students.	This quantitative study examines the relationship between parenting and character development but lacks a structured framework for mapping the future character development of gifted students.
[4]	The study reveals that parenting practices—such as cooperation, tolerance, warmth, peace, respect, and awareness—significantly contribute to children's character formation.	While the study proposes a parenting-based character development model, it does not provide a technological platform or system to support long-term career guidance for gifted students.
[10]	The research finds that character education significantly influences students' character formation through friendship.	The study highlights the importance of character education and peer relationships; however, further research is needed to explore how environmental systems can support gifted students' development.
[27]	The results show that parenting and friendship simultaneously and partially influence adolescents' self-esteem.	The study employs regression analysis but lacks the development of an application or system to map students' potential in relation to future career behavior.
[28]	The study develops a model of work productivity among educational employees during Work from Home conditions in the COVID-19 pandemic.	This study applies a multivariate quantitative approach but does not address the integration of student potential mapping systems or gifted education contexts.
[29]	The study demonstrates that the "Si Gabby" application effectively improves student learning achievement and supports potential identification.	Although developed using an R&D approach, the system does not specifically address the identification and development of GTS' potential.

3. RESEARCH METHOD

3.1 Research design

This study employed a research and development (R&D) design adapted from the Borg and Gall development framework and organized through the ADDIE model, which consists of analysis, design, development, implementation, and evaluation. The use of R&D was considered appropriate because this study aimed not only to test an existing intervention, but also to develop, validate, implement, and evaluate the BRIGHT system as a technology-based educational management tool for GTS. In this study, BRIGHT was designed as a digital educational management system to support gifted-student identification, organize individual student profiles, and generate personalized talent-development and career recommendations. The ADDIE framework was used to ensure that the development process followed a systematic sequence, beginning with needs analysis and ending with system evaluation [30].

The research paradigm emphasized technology-driven personality intervention in educational settings. In this context, digital intervention was understood as the use of digital coaching, personalized guidance, daily tasks, and feedback to facilitate behavioral change and habit formation [31]. The intervention was directed toward strengthening students' self-understanding, career awareness, learning preferences, and

readiness for future planning. The system was also supported by data-driven analysis, in which student assessment results were processed to generate individualized talent mapping and career recommendations. This approach is consistent with the purpose of BRIGHT as an adaptive educational management system for GTS.

The ADDIE stages were implemented as shown in Figures 3 and 4. In the analysis stage, the researchers identified the needs of GTS, teachers, parents, and schools through literature review, surveys, interviews, and observations. This stage focused on understanding the challenges of identifying student potential, mapping talent, and providing appropriate career guidance. In the design stage, the findings from the needs analysis were translated into system requirements, assessment indicators, user workflows, and recommendation criteria. In the development stage, the BRIGHT prototype was constructed based on these specifications and reviewed through expert judgment and limited user testing. In the implementation stage, the system was tested in selected schools, and users interacted directly with the application. In the evaluation stage, expert review, user feedback, questionnaire data, and system performance information were used to determine the feasibility and effectiveness of the system.

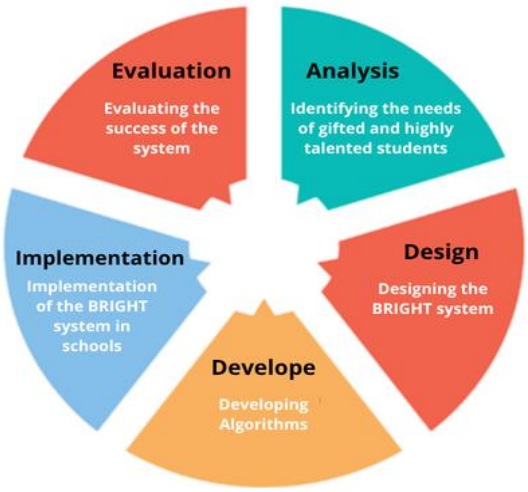

Figure 3. Phases of the ADDIE research model

The AHP was incorporated as the decision-support method within BRIGHT. AHP was selected because it enables multi-criteria evaluation by structuring complex decisions into goals, criteria, sub-criteria, and alternatives. In this study, AHP was used to support decision-making related to the selection, mapping, and development of gifted students by considering academic achievement, non-academic skills, interests, talent potential, learning style, career personality, and recommendations from educators. The integration of AHP was intended to enhance objectivity and accuracy in data-driven student selection and potential mapping processes [13]. Pairwise comparisons were used to determine the relative priority of each criterion, while consistency checking was conducted to ensure that the resulting judgments were logically acceptable. To strengthen the inclusive design of BRIGHT, the system was not developed to treat giftedness as a single academic or analytical score. Instead, giftedness was operationalized as a multidimensional profile consisting of academic achievement, non-academic skills, talent potential, career interests, learning preferences, career personality, and educator recommendations. Through the AHP-based decision structure, these indicators are interpreted as complementary criteria rather than as competing indicators that rank one type of giftedness above another. This means that students with strong analytical profiles, such as logical reasoning, science-oriented problem solving, or data-based thinking, can be identified differently from students with creative profiles, such as artistic expression, design thinking, communication ability, entrepreneurship, or social innovation potential. Therefore, BRIGHT is intended to generate profile-sensitive recommendations that recognize different forms of giftedness and reduce the risk that creative, interpersonal, or artistic students are overlooked because they do not always demonstrate giftedness through conventional academic indicators.

Operationally, BRIGHT was designed as an identification-to-career architecture consisting of student data input, psychological profiling, AHP-based decision support, talent-development recommendation, professional career mapping, and counselor-oriented reporting [32]–[34]. This architecture is original in its attempt to integrate psychological assessment and professional career mapping into a single decision-support system for GTS. The system was also designed with scalable data structures, allowing

potential integration with school-level, regional, or national education databases, provided that interoperability, privacy protection, and data governance standards are fulfilled [35].

User feedback was used as an explicit mechanism to improve system accuracy [36]. Feedback from students, teachers, parents, and experts was collected after users interacted with the BRIGHT prototype through questionnaires, interviews, and observations. The feedback was then classified into several improvement areas, including unclear assessment items, difficulty in navigating the interface, incomplete interpretation of student profiles, and mismatches between student characteristics and system-generated recommendations. These findings were compared with the AHP priority results and student assessment profiles. When inconsistencies were identified, the researchers revised item wording, refined criteria interpretation, improved recommendation rules, and adjusted the user interface [37]. The revised version was then retested to reduce mismatches between student profiles and the recommendations produced by the system. Therefore, user feedback was not treated merely as satisfaction data, but also as an iterative validation input for improving the accuracy of potential mapping and career recommendation.

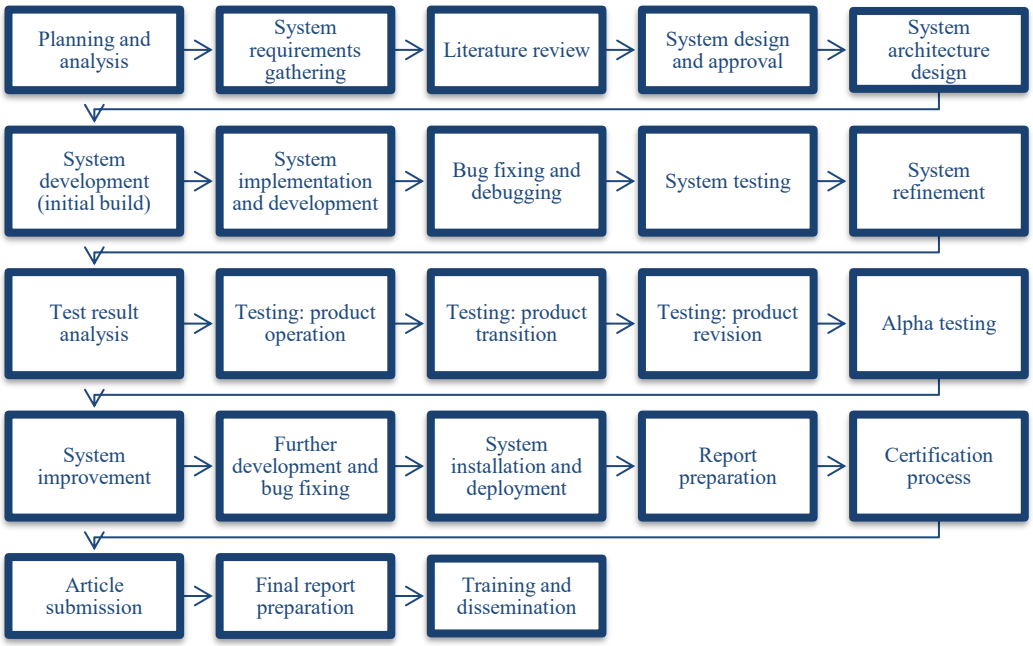

Figure 4. Detail phases of the ADDIE research model

3.2. Participants

The population of this study consisted of senior high school and vocational high school students from Central Java, the Special Region of Yogyakarta, and East Java. The initial recruitment involved 500 GTS as the target participants for system implementation and data collection. However, after data screening, 392 students provided complete and analyzable data and were therefore included in the final statistical analysis. This clarification was made to ensure consistency between the method and results sections.

The final sample consisted of students from SMK 1 Madiun, MAN 1 Sleman, and SMA Negeri 11 Semarang. The participants included 212 male students and 180 female students aged 16 to 18 years. The study was conducted in classroom settings with adequate internet infrastructure so that participants could access and use the BRIGHT application properly. The use of school-based implementation allowed the researchers to observe how the system functioned in real educational contexts and to collect responses from users after direct interaction with the application.

3.3. Instruments

Data were collected using five standardized scales: the career interest scale, talent and potential excellence scale, learning style and work environment scale, career personality scale, and career readiness and planning scale. These instruments were used to identify students' interests, talents, learning preferences, work environment fit, personality characteristics, and readiness for career planning. The instruments also provided the main input for the AHP-based recommendation process in BRIGHT.

Instrument validation was conducted in a simplified but systematic sequence. First, items were developed based on the constructs measured by the BRIGHT system. Second, experts in educational psychology, educational technology, and application development reviewed content relevance, language clarity, and item suitability. Third, the items were revised based on expert feedback and tested on respondents with characteristics similar to the target population. Fourth, validity and reliability analyses were performed. One item in the career interest scale was removed because it did not meet the validity criterion, while the remaining items across the five scales showed acceptable to strong validity coefficients ranging from 0.700 to 0.855. Reliability testing also showed strong internal consistency, with Cronbach's alpha values ranging from 0.900 to 0.921.

3.4. Data analysis

Data analysis was conducted in a structured sequence to make the methodological procedure clearer and easier to follow. First, descriptive statistics were used to summarize participant demographics and classify students' scores into low, moderate, and high categories for each measured dimension. These categories were used to describe students' career interest, talent and potential excellence, learning style and work environment fit, career personality, and career readiness and planning. Second, validity and reliability analyses were conducted to examine the quality of the instruments. Item validity coefficients were used to evaluate whether each item measured the intended construct, while Cronbach's alpha was used to assess internal consistency.

Third, a normality test was conducted to determine the appropriate correlation procedure. Because the data were not normally distributed, Spearman's rho correlation was used to examine the relationship between BRIGHT outputs and each career-development dimension. This analysis was used to determine whether the BRIGHT system showed significant associations with career interest, talent and potential excellence, learning style and work environment, career personality, and career readiness and planning. Fourth, AHP analysis was used to support the decision-making component of the BRIGHT system. The relevant criteria and sub-criteria were organized into a hierarchy, pairwise comparisons were conducted, priority weights were calculated, and consistency was checked before producing final student potential maps and career recommendations.

Qualitative data obtained from interviews, observations, and user comments were analyzed thematically. This analysis focused on identifying usability problems, recommendation mismatches, unclear assessment items, and features that required further development. The qualitative findings were then integrated with expert review and quantitative results to refine the BRIGHT system. Through this procedure, the evaluation process combined system feasibility analysis, user satisfaction analysis, instrument testing, AHP-based decision analysis, and qualitative feedback analysis. This integrated analysis provided a clearer basis for determining the feasibility, accuracy, and effectiveness of BRIGHT as a technology-based educational management system for GTS [38].

4. RESULTS

The results are presented in relation to the central problem of career mismatch risk, which refers to the possibility that students' interests, talents, personality characteristics, learning preferences, and career readiness are not sufficiently aligned with appropriate educational and occupational pathways. Complete response data were obtained from 392 students from three schools, namely SMK 1 Madiun, MAN 1 Sleman, and SMA Negeri 11 Semarang. As shown in Table 2, the distribution of respondents was relatively balanced across school origin, gender, and age. SMK 1 Madiun contributed 145 students (37.0%), followed by SMA Negeri 11 Semarang with 124 students (31.6%), and MAN 1 Sleman with 123 students (31.4%). Male respondents accounted for 212 students (54.1%), while female respondents accounted for 180 students (45.9%). The age distribution was also proportionate, consisting of 121 students aged 16 years (30.9%), 144 students aged 17 years (36.7%), and 127 students aged 18 years (32.4%). This demographic pattern indicates that the BRIGHT system was evaluated across a diverse student profile, allowing the findings to reflect different school contexts and adolescent developmental stages.

Table 2 shows that most respondents were classified in the moderate to high categories across all measured dimensions. The proportion of students in the low category was consistently small, ranging from 12.2% to 15.3%, suggesting that most participants had relatively favorable indicators of person-career alignment. Career readiness and planning showed the strongest distribution, with 204 students (52.0%) in the high category, indicating that more than half of the respondents had developed a clear orientation toward future career planning. Career interest was also dominated by the high category, involving 181 students (46.2%), while learning style and work environment reached 179 students (45.7%) in the high category, and career personality reached 178 students (45.4%). Talent and potential excellence was led by the moderate category, with 169 students (43.1%), followed closely by the high category, with 163 students (41.6%).

This pattern suggests that students generally demonstrate positive career development indicators, while the moderate level of talent and potential excellence highlights the continuing need for structured talent identification and personalized development support. This finding is consistent with studies emphasizing that gifted students require systematic identification, differentiated support, and contextual guidance to optimize their potential and reduce the risk of future career misalignment [1], [3], [18], [20], [27], [28].

The distribution of measured variables in Table 3 indicates that BRIGHT is not merely a management tool, but a diagnostic system for identifying dimensions that may contribute to career mismatch risk. High levels of career interest, learning style and work environment, career personality, and career readiness suggest that the system can help students recognize their preferences, strengths, and future orientation. At the same time, the dominance of the moderate category in talent and potential excellence indicates that gifted potential requires continuous intervention, mentoring, and evidence-based mapping. This interpretation is supported by literature showing that talent and interest must be aligned to strengthen motivation, productivity, and future career suitability, while self-awareness and structured development are essential for making accurate career decisions [21]–[24], [39]. Therefore, the results imply that BRIGHT contributes to early detection of possible mismatch between students' internal characteristics and future career pathways.

Table 2. Demographic profile of participants

Demographic category		Frequency	Percentage (%)
School origin	SMK 1 Madiun	145	37.0
	MAN 1 Sleman	123	31.4
	SMA Negeri 11 Semarang	124	31.6
Gender	Male	212	54.1
	Female	180	45.9
Age	16 years	121	30.9
	17 years	144	36.7
	18 years	127	32.4

Table 3. Categorization of measured variables

Aspect	Category	Frequency	Percentage (%)
Career interest	Low	58	14.8
	Moderate	153	39.0
	High	181	46.2
Talent and potential excellence	Low	60	15.3
	Moderate	169	43.1
	High	163	41.6
Learning style and work environment	Low	55	14.0
	Moderate	158	40.3
	High	179	45.7
Career personality	Low	50	12.8
	Moderate	164	41.8
	High	178	45.4
Career readiness and planning	Low	48	12.2
	Moderate	140	35.7
	High	204	52.0

The validity and reliability results further support the quality of the measurement instruments used in evaluating BRIGHT. In the career interest scale, one item was excluded because it did not meet the validity requirement, while the remaining items showed validity coefficients ranging from 0.720 to 0.823 and a Cronbach's alpha of 0.907. The talent and potential excellence scale showed validity coefficients between 0.715 and 0.855, with a reliability coefficient of 0.921. The learning style and work environment scale produced validity coefficients between 0.708 and 0.821 and a reliability coefficient of 0.911. The career personality scale had validity coefficients ranging from 0.700 to 0.811, with a reliability coefficient of 0.911. Finally, the career readiness and planning scale showed validity coefficients between 0.746 and 0.820 and a reliability coefficient of 0.900. These results indicate that all instruments met acceptable psychometric standards and were suitable for measuring the main dimensions related to career mismatch risk. The reliability of these instruments is important because previous research has shown that technology-based educational evaluation, student satisfaction analysis, and structured intervention models require valid and consistent measurement tools to produce meaningful decision support outputs [30], [31], [34].

The normality test showed a significance value of 0.000, indicating that the data were not normally distributed. Therefore, Spearman's rho correlation was used as the appropriate nonparametric analysis.

As presented in Table 4, all measured dimensions showed significant positive correlations with the BRIGHT system, with p values reported as 0.000, indicating $p<0.001$. The strongest correlation was found in learning style and work environment ($\rho=0.762$), followed by talent and potential excellence ($\rho=0.743$), career interest ($\rho=0.716$), career personality ($\rho=0.693$), and career readiness and planning ($\rho=0.672$). These coefficients indicate strong associations across all dimensions, showing that BRIGHT performs consistently in mapping the major factors that influence person-career fit. The highest coefficient in learning style and work environment suggests that the system is particularly useful for aligning students' learning preferences with suitable academic and occupational environments. Meanwhile, the strong correlations in talent, interest, personality, and readiness indicate that BRIGHT can support integrated career profiling rather than fragmented assessment. These findings indicate that BRIGHT can help detect early mismatch patterns, such as high talent but low career readiness, strong interest but weak learning-environment fit, or strong analytical ability but limited career exploration.

Table 4. Spearman's rho correlation results

Aspect	ρ (Rho)	p-value
Career interest	0.716	0.000
Talent and potential excellence	0.743	0.000
Learning style and work environment	0.762	0.000
Career personality	0.693	0.000
Career readiness and planning	0.672	0.000

5. DISCUSSION

These findings clarify the practical value of BRIGHT for guidance counselors by shifting career recommendation from intuition-based judgment to data-driven decision-making. Rather than relying only on general academic achievement or teacher impressions, counselors can use BRIGHT outputs to compare students' interests, talent profiles, learning preferences, personality tendencies, and career readiness before recommending enrichment programs, subject specialization, mentoring, internships, or further psychological consultation. The strongest descriptive result appeared in career readiness and planning, where 52.0% of respondents were in the high category, followed by career interest at 46.2%, learning style and work environment at 45.7%, career personality at 45.4%, and talent and potential excellence at 41.6%. These findings suggest that BRIGHT does not merely identify giftedness as a general intellectual attribute, but also connects students' strengths with career-relevant indicators. This interpretation is consistent with the view that GTS require differentiated educational services, enrichment, and systematic support to prevent underachievement and to optimize their unique potential [1], [3], [18], [28], [40].

The correlation results further strengthen this interpretation. Spearman's rho analysis showed significant positive relationships between BRIGHT outputs and all measured dimensions, including learning style and work environment ($\rho=0.762$), talent and potential excellence ($\rho=0.743$), career interest ($\rho=0.716$), career personality ($\rho=0.693$), and career readiness and planning ($\rho=0.672$). These coefficients indicate that the system is strongly associated with students' self-understanding, potential mapping, learning-environment alignment, and career preparation. The highest correlation in learning style and work environment suggests that BRIGHT is particularly effective in helping students understand how they learn and what types of environments may support their performance. This finding is relevant to research on cognitive load and learning environments, which emphasizes that the suitability of learning media and learning conditions can influence students' cognitive processing and learning effectiveness [41]. It also supports the argument that adaptive and personalized educational technologies can improve learning alignment by adjusting content, feedback, and recommendations to individual learner characteristics [9], [13].

The strong relationship between BRIGHT and talent and potential excellence ($\rho=0.743$) confirms that the system is able to capture diverse forms of student potential rather than relying only on conventional academic indicators. This finding is important because giftedness is not limited to logical or analytical intelligence, but may also appear in creative, social, artistic, leadership, technological, entrepreneurial, and practical domains. In terms of inclusive design, BRIGHT interprets giftedness as a multidimensional profile by combining academic achievement, non-academic skills, career interests, learning preferences, personality tendencies, and educator recommendations. Therefore, the system does not classify gifted students only according to academic superiority but attempts to identify the dominant pattern of each student's strengths and developmental needs.

For students with analytical giftedness, BRIGHT may indicate stronger alignment with pathways that require logical reasoning, structured problem solving, scientific inquiry, computational thinking, engineering design, data analysis, or research-oriented learning. These students may benefit from advanced subject specialization, science or technology enrichment, research mentoring, Olympiad preparation,

or project-based learning that emphasizes evidence-based reasoning. In contrast, students with creative giftedness may show stronger alignment with originality, divergent thinking, artistic expression, communication, design, entrepreneurship, leadership, or social innovation. For these students, BRIGHT may recommend portfolio-based enrichment, creative project development, design-oriented learning, communication activities, entrepreneurial mentoring, or interdisciplinary programs that allow creative talent to be transformed into meaningful educational and career pathways.

This interpretation shows that BRIGHT supports inclusive gifted education by recognizing that different gifted students require different forms of educational support. A student with high analytical potential but low career readiness may need mentoring and career exploration before being directed toward a technical or research pathway. A student with high creative potential but moderate academic achievement should not be interpreted as less gifted, but as requiring a different type of enrichment and assessment, such as creative production, portfolio development, collaborative projects, or innovation-based activities. Thus, BRIGHT helps reduce career mismatch risk by aligning each student's giftedness with suitable learning environments, developmental interventions, and career recommendations rather than forcing all gifted students into the same academic or professional trajectory. The interpretation is aligned with multiple intelligences theory, which argues that intelligence is plural and may include linguistic, logical-mathematical, spatial, bodily-kinesthetic, interpersonal, and intrapersonal dimensions [42]. In this study, BRIGHT responds to such diversity by integrating several indicators, including academic achievement, non-academic skills, career interests, learning preferences, personality tendencies, and educator recommendations. Therefore, the system can support inclusive gifted education by recognizing both analytical giftedness and creative giftedness. Students with strong analytical abilities may be directed toward science, technology, engineering, data analysis, or research-oriented pathways, while students with creative, interpersonal, or artistic strengths may receive recommendations related to design, communication, entrepreneurship, arts, leadership, or social innovation. This inclusive interpretation is consistent with the concept that gifted students possess varied strengths and require educational systems that are flexible enough to accommodate different profiles of excellence [18], [28], [40].

The finding that career interest had a strong correlation with BRIGHT outputs (ρ=0.716) also demonstrates that the system is able to connect students' internal preferences with their potential career pathways. This result supports the theoretical argument that the alignment between talent and interest is essential for career development. Talent provides the capacity for high performance, while interest provides motivation, persistence, and sustained engagement. When both are aligned, students are more likely to experience higher productivity, stronger creativity, and more stable career satisfaction. Conversely, when talent and interest are mismatched, students may experience disengagement, reduced motivation, and occupational misfit [36]. In this sense, BRIGHT contributes to early career optimization by helping students recognize whether their abilities, interests, and personality characteristics point toward coherent educational and occupational pathways. This is particularly important for gifted students because high ability without appropriate direction may lead to boredom, psychosocial imbalance, or underachievement [3], [18], [20].

The relationship between BRIGHT and career personality (ρ=0.693) indicates that the system also contributes to understanding students' psychological tendencies in relation to future work demands. Although this coefficient was lower than learning style, talent potential, and career interest, it remained in the strong category. This suggests that personality-related career guidance may require more contextual interpretation because personality development is influenced not only by individual traits, but also by parenting, peer relationships, emotional intelligence, school culture, and social experience [1], [4], [10], [27]. The result is also consistent with the findings that character, self-esteem, and social competence are important components of student development, particularly among gifted learners who may face social isolation, perfectionism, heightened sensitivity, or emotional imbalance [3], [18]. Therefore, BRIGHT should not be interpreted as replacing psychological counseling, but as a decision-support tool that provides structured data for counselors, teachers, and parents to discuss students' strengths, risks, and developmental needs more objectively.

The career readiness and planning dimension also showed a significant positive relationship with BRIGHT outputs (ρ=0.672). Although this was the lowest correlation among the five dimensions, the descriptive results showed that it had the highest proportion of students in the high category. This pattern suggests that many students already possessed relatively strong career readiness, while BRIGHT helped organize and clarify this readiness through structured feedback and career mapping. The lower correlation may indicate that career planning is influenced by additional factors beyond the system, such as family expectations, socioeconomic background, access to career information, school counseling quality, and perceived labor-market opportunities. This finding provides a more critical interpretation of the system's role. BRIGHT is effective in supporting career readiness, but readiness itself remains a complex developmental outcome that requires continuous mentoring, experiential learning, parental involvement, and school-based guidance programs [1], [30], [31], [39].

The effectiveness of BRIGHT can be explained by three main mechanisms. First, the system integrates multiple student data sources, including interests, talent potential, learning style, work environment preference, personality, and readiness for planning. This multidimensional structure reduces dependence on a single test score and allows a more comprehensive interpretation of giftedness. Second, the use of the AHP enables systematic multi-criteria decision-making by weighting relevant indicators and producing more transparent recommendations [13]. Third, the technology-based design allows assessment results to be processed into personalized feedback that can be accessed and discussed by students, teachers, and guidance counselors. This mechanism reflects the broader role of AI and digital systems in personalized learning, where student data can be used to identify needs, recommend suitable resources, and provide timely feedback [5], [9], [37], [38]. AI-supported learning can foster creativity and application skills when combined with active and reflective learning processes [13]. Similarly, machine learning and AI can support the interpretation of complex human data when used carefully and ethically [37].

These findings also clarify the practical value of BRIGHT for guidance counselors. In many schools, student career recommendations are still heavily influenced by intuition, general academic achievement, teacher impressions, or limited counseling records. BRIGHT helps shift this process from intuition-based recommendation to data-driven recommendation. Counselors can use the system outputs to identify whether a student's interests match their talent profile, whether their learning style fits the recommended educational pathway, and whether their personality and readiness support the suggested career direction. This enables counselors to provide more specific guidance, such as recommending enrichment programs, mentoring activities, career exploration tasks, subject specialization, internship pathways, or further psychological consultation. In this way, BRIGHT does not eliminate the professional role of counselors, but strengthens it by providing structured evidence for counseling decisions. This is consistent with studies emphasizing that educational technology should support, rather than replace, human judgment in learning and decision-making processes [6], [9], [20].

The findings also have implications for data scalability. Because BRIGHT is designed as a digital educational management system, it has potential to be integrated into broader school, district, provincial, and national education databases. If implemented at scale, the system could support longitudinal monitoring of gifted students from early identification to higher education and career preparation. National integration would allow policymakers to map the distribution of giftedness across regions, identify gaps in access to enrichment programs, evaluate the effectiveness of career guidance services, and design targeted interventions for students with different profiles of giftedness. However, such scalability requires strong data governance, interoperability with existing educational databases, standardized assessment protocols, privacy protection, and transparent rules for data access. The use of AI and decision-support systems in education must be accompanied by ethical safeguards, particularly regarding student privacy, algorithmic transparency, potential bias, and the risk of reducing complex human potential into overly rigid categories [5], [6], [8], [37].

Compared with previous studies, the contribution of BRIGHT lies in its integration of gifted-student identification, personalized development planning, and career recommendation within a single educational management system. Earlier studies have emphasized the importance of parenting, character development, social competence, and counseling for gifted and adolescent development [1], [3], [4], [10], [27]. Other studies have highlighted the potential of AI, adaptive learning, and machine learning in supporting personalized education, cognitive assessment, and data-driven decision-making [7], [9], [13], [37], [38]. The present study extends these findings by applying a technology-based system specifically to GTS and by linking potential mapping directly with career readiness and planning. Thus, the findings support previous literature on the importance of individualized support, but differ by demonstrating how these principles can be operationalized through an integrated BRIGHT system.

6. IMPLICATIONS AND LIMITATIONS

The findings of this study have practical implications for schools, guidance counselors, and educational psychologists who work with GTS. BRIGHT can support schools in identifying students' interests, talent profiles, learning preferences, personality tendencies, and career readiness in a more structured and data-informed manner. The system can also help counselors formulate more specific recommendations, such as enrichment programs, mentoring activities, subject specialization, career exploration, internship preparation, or further psychological consultation. Thus, BRIGHT should be understood as a decision-support tool that strengthens professional judgment rather than as a replacement for counselors, teachers, or educational psychologists.

The study also has implications for educational management and policy development. Since BRIGHT is designed as a digital educational management system, it has the potential to support longitudinal monitoring of gifted students from early identification to higher education and career preparation. At the school level, the system may help institutions organize student-profile data and reduce dependence on

fragmented or intuition-based career guidance. At the broader policy level, BRIGHT may contribute to the development of a scalable database-oriented model for gifted education management, provided that data privacy, interoperability, ethical safeguards, and transparent governance standards are carefully implemented.

Theoretically, this study contributes to gifted education research by integrating gifted-student identification, psychological profiling, AHP-based decision support, personalized talent-development planning, and career recommendation within one coherent system. Previous approaches often examined giftedness, counseling, educational technology, or career guidance separately, whereas BRIGHT connects these dimensions into an identification-to-career framework. This contribution is important because gifted students require not only academic enrichment, but also systematic support for aligning their potential, interests, personality characteristics, learning environments, and future career pathways.

Nevertheless, several limitations should be acknowledged. First, the study involved 392 analyzable respondents from three schools in Central Java, the Special Region of Yogyakarta, and East Java, so the findings cannot yet be generalized to all GTS in Indonesia. Second, the study relied on self-report instruments, which may be influenced by social desirability, limited self-awareness, or response bias. Third, correlational design confirms significant associations between BRIGHT outputs and career-development dimensions, but it does not establish causal effects. Fourth, although AHP improves decision-making transparency, the weighting of criteria still depends on expert judgment and user input, which may vary across institutional contexts. Fifth, the current evaluation focused on initial system effectiveness and user-related outcomes, while long-term impacts on academic achievement, career-choice accuracy, socio-emotional development, and labor-market fit have not yet been tested.

Future research should involve larger and more representative samples from different provinces and school types. Further studies should also compare BRIGHT with conventional counseling approaches to determine whether the system produces better accuracy in potential mapping and career recommendation. Longitudinal research is needed to examine whether BRIGHT recommendations remain consistent and useful across students' educational and career trajectories. In addition, future development should include bias testing, data security evaluation, counselor training modules, and integration trials with existing school information systems. Future validation should also examine whether BRIGHT produces equally accurate and fair recommendations across different types of giftedness, including analytical, creative, artistic, interpersonal, entrepreneurial, and leadership-oriented giftedness, so that the system can be further strengthened as an inclusive decision-support tool for gifted education.

7. CONCLUSION

This study developed and evaluated the BRIGHT system as a technology-based educational management system for optimizing career development among GTS. The findings showed that most students were categorized at moderate to high levels across the measured career-development dimensions. Career readiness and planning recorded the strongest descriptive result, with 52.0% of respondents in the high category, followed by career interest, learning style and work environment, career personality, and talent and potential excellence. These findings indicate that GTS generally possess positive career-development characteristics, but still require structured guidance to align their interests, talents, learning preferences, personality traits, and career readiness with appropriate educational and occupational pathways.

The correlation analysis confirmed that BRIGHT was significantly associated with all measured career-development dimensions. Spearman's rho coefficients ranged from 0.672 to 0.762, with the strongest association found in learning style and work environment, followed by talent and potential excellence, career interest, career personality, and career readiness and planning. This pattern demonstrates that BRIGHT can function as an integrated profiling system that supports self-understanding, potential mapping, learning-environment alignment, personality-based career consideration, and readiness for future career planning. Therefore, the system provides empirical support for data-driven career optimization among GTS.

The main contribution of this study is the development of BRIGHT as an integrated identification-to-career system designed to reduce career mismatch risk among GTS. By combining psychological profiling, AHP-based decision support, personalized talent-development planning, and professional career mapping, BRIGHT offers a structured alternative to conventional school management systems and intuition-based counseling practices. This contribution advances gifted education management by providing a school-based model that integrates potential identification, personalized development planning, and data-driven career recommendation within a single educational management framework.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

The research related to human use has been complied with all the relevant national regulations and institutional policies in accordance with the tenets of the Helsinki Declaration and has been approved by the authors' institutional review board or equivalent committee.

DATA AVAILABILITY

The data that support the findings of this study are available on request from the corresponding author, [RS]. The data, which contain information that could compromise the privacy of research participants, are not publicly available due to certain restrictions.

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