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Development of a Google Workspace-Based Learning Style Detection Application to Enhance Student Engagement in Differentiated High School Learning

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Abstract

Facts in the field show that low student engagement often stems from teaching strategies that do not align with students' diverse learning styles. This challenge is particularly pronounced in differentiated learning settings, where effectively identifying individual learner preferences (visual, auditory, kinesthetic) is crucial yet difficult to achieve efficiently on a large scale. At SMAN 1 Bantaran, for instance, the lack of a systematic and scalable diagnostic tool has resulted in prolonged periods of low engagement and ineffective personalization. This study addresses this gap by developing a scalable, technology-based solution. The primary aim is to develop and implement a Google Workspace-based learning style detection application to increase student engagement in differentiated learning for high school students. The research method uses Research and Development (R&D) with the ADDIE model. The analysis includes: Needs analysis through observation and interviews to identify problems related to student engagement; Application design using Google Workspace; Questionnaire development, validation by media and content experts, and trial testing on five students; Implementation on Grade XI Package A students; and Evaluation of effectiveness using quantitative analysis (Aiken's V, N-Gain) and qualitative methods (questionnaires, interviews, observations). The collection of pretest, posttest, and effectiveness questionnaire data was then analyzed to assess validity, effectiveness, and increased engagement. The results showed that the application was highly valid (V = 0.95) and effective (87.86%) based on expert assessment and user satisfaction. Student engagement increased by 10.95% with a moderate category (N-Gain = 0.39). The distribution of learning styles showed a balance (4 kinesthetic, 5 auditory, 5 visual). In conclusion, this application has the potential to improve differentiated learning, although further development is needed for optimal results.

Keywords: Learning Style Detection Application, Student Engagement, Differentiated Learning

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INTRODUCTION

Education in the digital era demands a student-centered approach to accommodate diverse learning needs. At SMAN 1 Bantaran, Probolinggo, low student engagement is a primary issue due to teaching methods that are not tailored to individual learning styles, such as visual, auditory, or kinesthetic. This mismatch results in reduced student activity, low participation, and suboptimal learning

outcomes (Supit et al., 2023). Differentiated learning, which adapts content, processes, and products to students' needs, offers a relevant solution (Silmi et al., 2025). However, its implementation is hindered by the lack of efficient tools for detecting learning styles, as manual approaches are time-consuming and prone to errors (Ngatirin & Zainol, 2021).

Advancements in cloud-based educational technology, such as Google Workspace, offer effective solutions to enhance differentiated learning by addressing students' diverse learning styles (Hidayati, 2024; Rakhmi et al., 2023). Studies indicate that Google Forms facilitates rapid and accurate data collection (Widayanti, 2021), Google Sheets enables automated data analysis (Pebralia et al., 2023), and Google Sites supports effective dissemination of results (Febrian & Nasution, 2024; Tamrin et al., 2024). At SMAN 1 Bantaran, digital tools are essential for identifying students' learning styles (visual, auditory, kinesthetic) to support tailored teaching strategies. A study demonstrates that validated learning style detection instruments significantly improve student engagement by enabling personalized instruction (Buntins et al., 2021). To address this need, developing a learning style detection application using Google Workspace is a promising solution (Oliynyk et al., 2024; Thuan & Hanh, 2024). This application leverages Google Forms for questionnaire-based data collection, Google Sheets for automated analysis, Google Slides for presenting results, and Google Sites for sharing outcomes with stakeholders. This integrated, cloud-based approach provides a practical and scalable solution to enhance student engagement at SMAN 1 Bantaran.

Learning-style detection applications represent a technological response to the enduring popularity of learner categorization models like VAK (visual, auditory, kinesthetic) in educational practice (Anugrah & Muliati, 2025; Sulaiman et al., 2024). These digital tools use questionnaires or interactive tasks to diagnose preferences, aiming to personalize content delivery—for instance, providing more visual aids to "visual learners" (Alfarisi, 2024; Fadhila et al., 2024). The perceived benefit lies in potentially enhancing student engagement and motivation when instructional methods appear aligned with individual preferences (Koimah et al., 2024; Sharma, 2024).

However, the academic foundation of strict learning-style matching faces substantial criticism in contemporary literature. Recent reviews emphasize the lack of robust empirical evidence that tailoring instruction to VAK modalities improves learning outcomes (Hussain et al., 2024; Johannsen et al., 2023). Scholars caution against a rigid interpretation of these models, noting they may oversimplify the complex, contextual, and dynamic nature of cognitive processing (Sohaib et al., 2025; Thangavel, 2024). This study acknowledges this critical perspective. Its objective is not to validate the VAK theory per se, but to address a pragmatic reality: many educators still seek scalable tools to efficiently diagnose student preferences as a starting point for differentiation (Kanchon et al., 2024). The development of a detection application is thus positioned as a practical intervention within a specific educational context where such diagnostics are in demand.

Regardless of theoretical debates, student engagement—characterized by active participation, interest, and persistence—remains a crucial determinant of academic success in digital and blended environments (Huang & Wang, 2023).

Research consistently shows that strategies perceived by students as personalized or responsive to their needs can significantly boost this engagement (Han, 2021; Mehenaoui et al., 2022). Here, integrated digital platforms play a pivotal role. Google Workspace (including Classroom, Forms, and Docs) has been widely adopted for its ability to foster collaboration, streamline feedback, and provide accessible, interactive materials—all factors known to support engaged learning (Hernawan et al., 2025; Nurkhin & Rohman, 2023).

Therefore, this study proposes that embedding a learning-style diagnostic within the familiar, functional ecosystem of Google Workspace could offer a streamlined workflow for teachers. By reducing the friction in diagnosing and implementing varied instructional approaches, the tool aims to make differentiated practice more manageable. The ultimate hypothesis is that this technology-assisted process can increase teachers' efficacy and, consequently, enhance overall student engagement in differentiated learning activities, as suggested by prior research on web-based diagnostic tools (Kanchon et al., 2024).

Differentiated learning enhances student engagement by tailoring content, teaching methods, and assessments to match individual needs, interests, and learning styles (Zulaikha & Laeli, 2023). This approach not only strengthens critical thinking but also fosters active participation as students feel more connected to learning methods that suit their preferences (Avandra & Desyandri, 2023). However, the main challenge lies in the lack of practical tools to accurately identify learning styles, which is crucial for maximizing student engagement. Studies show that differentiated learning improves academic performance, particularly in subjects like social studies, by presenting material in ways that are most accessible to students (Nur Intang et al., 2025; Nursanti et al., 2025). Furthermore, this approach strengthens competency development when teaching strategies align with students' visual, auditory, or kinesthetic learning preferences (London, 2022; Pascu, 2024). Educational technology tools like Google Workspace support this process by analyzing learning preference data and enabling more personalized instruction, thereby increasing student motivation and participation (Emilzoli et al., 2025; Najemi et al., 2024).

Previous studies indicate that web-based technology is effective in detecting students' learning styles to support differentiated learning. Rule-based reasoning in e-assessments accurately identifies learning styles (Latifah & Harani, 2025). Web-based expert systems using forward chaining method also effectively identify visual, auditory, and kinesthetic learning styles in adolescents, while automated web-based learning style identification applications improve assessment efficiency (Adistyan et al., 2025; Arimbi et al., 2021; Sapriadi et al., 2023). Additionally, a web-based expert system utilizing the Forward Chaining and Certainty Factor Method has proven effective in identifying students' learning modalities to support both online and offline learning at SMK PGRI 2 Serang City (Hardiansyah et al., 2022). These studies collectively highlight the potential of web-based technologies to enhance personalized learning experiences by effectively identifying and accommodating diverse learning styles. Unlike previous studies, this research develops a learning style detection application using Google Workspace, integrating Google Forms for questionnaires, Google Sheets for automated analysis, Google Slides for reporting, and Google Sites for result dissemination, offering an

affordable, cloud-based, integrated solution to enhance student engagement at SMAN 1 Bantaran.

This study formulates two main research problems related to the development and application of a learning style detection application at SMAN 1 Bantaran. First, how to develop a valid and effective learning style detection application to identify students' learning styles at SMAN 1 Bantaran. Second, how effective is the application in enhancing student engagement in differentiated learning at SMAN 1 Bantaran. To address these issues, the study adopts a Research and Development (R&D) approach using the ADDIE model (Analyze, Design, Develop, Implement, Evaluate) to develop a Google Workspace-based learning style detection application that integrates Google Docs, Google Forms, Google Sheets, Google Slides, and Google Sites into a single system. The objectives of this study are to develop a valid and effective learning style detection application using Google Workspace to identify students' learning styles at SMAN 1 Bantaran and to measure its effectiveness in enhancing student engagement in differentiated learning. Thus, this research aims to produce a technological solution that supports a more personalized learning approach and increases students' active participation in the learning process.

This study formulates two main research problems related to the development and application of a learning style detection application at SMAN 1 Bantaran. First, how to develop a valid and effective learning style detection application to identify students' learning styles at SMAN 1 Bantaran. Second, how effective is the application in enhancing student engagement in differentiated learning at SMAN 1 Bantaran.

While prior research has explored web-based learning style detection tools (e.g., Kanchon et al., 2024), a significant gap remains in the development of solutions that are simultaneously affordable, easily scalable, and seamlessly integrated into the existing digital ecosystem of schools. Many existing tools are standalone platforms, requiring additional costs, separate logins, and specialized training, which hinders widespread adoption, particularly in public secondary education settings like SMAN 1 Bantaran.

To address this gap, the primary novelty of this study lies in the development of a learning style detection system built entirely within the Google Workspace ecosystem. This research adopts a Research and Development (R&D) approach using the ADDIE model (Analyze, Design, Develop, Implement, Evaluate) to develop an application that integrates native tools—Google Forms for assessment, Google Sheets for automated analysis and profiling, Google Slides and Docs for differentiated content delivery, and Google Sites as a unified portal. This integrated approach eliminates the need for new software, leverages familiar tools to reduce the learning curve for teachers and students, and ensures high scalability and affordability.

Thus, the objectives of this study are: (1) to develop a valid and effective Google Workspace-based learning style detection application, and (2) to measure its effectiveness in enhancing student engagement in differentiated learning. By doing so, this research aims to provide a practical, context-sensitive technological solution that directly supports personalized learning and increases active participation in the classroom.

METHODS

This study employs a Research and Development (R&D) approach using the ADDIE model, which consists of five stages: Analyze, Design, Develop, Implement, and Evaluate. The stages include: (1) Needs analysis through observations and interviews at SMAN 1 Bantaran to identify issues related to student engagement; (2) Application design using Google Workspace; (3) Development of a questionnaire with 20 questions, validated by media and content experts and tested on five students; (4) Implementation with Class XI Package A students; and (5) Evaluation of effectiveness using quantitative analysis (Aiken's V, N-Gain) and qualitative methods (questionnaires, interviews, observations). Data were collected from 14 students through pretests, posttests, and effectiveness questionnaires, then analyzed to assess validity, effectiveness, and improvements in engagement.

This study employs a Research and Development (R&D) approach using the ADDIE model, consisting of five stages: Analyze, Design, Develop, Implement, and Evaluate. The stages include: (1) needs analysis through observations and interviews at SMAN 1 Bantaran to identify issues related to student engagement; (2) application design utilizing Google Workspace; (3) development of a 20-item questionnaire validated by media and content experts and pilot-tested with five students; (4) implementation with Class XI Package A students; and (5) evaluation of effectiveness using quantitative analysis (Aiken's V, N-Gain) and qualitative methods (questionnaires, interviews, observations). Data were collected from 14 students through pretests, posttests, and effectiveness questionnaires, then analyzed to assess validity, effectiveness, and improvements in engagement. It should be noted that this study is still at the preliminary development and formative evaluation stage. The relatively small sample size (14 students during implementation and 5 students during initial testing) limits the generalizability of the findings. Therefore, the results obtained should be regarded as preliminary and formative in nature, primarily intended to provide input for product refinement, rather than conclusive evidence of the instructional effectiveness on a broader scale. Further studies with larger and more representative samples are necessary to draw stronger and more generalizable conclusions.

The Google Forms-based questionnaire consists of 20 multiple-choice questions covering three learning style categories: visual, auditory, and kinesthetic, used to detect students' learning styles. The collected data are automatically analyzed using Google Sheets. Detection results are presented in PDF reports based on Google Slides templates, while Google Sites serves as the distribution platform to deliver results to students.

This questionnaire was developed in collaboration with the guidance and counseling teacher at SMAN 1 Bantaran by adapting items from existing VAK (Visual-Auditory-Kinesthetic) learning style instruments commonly used in educational use. Items were contextualized for Indonesian high school students, considering language and relevant scenarios. The development process included: (1) literature review on VAK learning style theory, (2) selection and adaptation of items to ensure balance across the three learning style categories, (3) validation by two experts (content and media) using a 1–4 validation sheet (not valid to very

valid), and (4) pilot testing with five students for clarity, readability, and completion time

Construct validity was assessed through expert judgment, focusing on item relevance to visual (e.g., preference for diagrams), auditory (e.g., preference for discussions/oral explanations), and kinesthetic (e.g., preference for hands-on activities) dimensions. However, it should be noted that learning style theories (including VAK) remain controversial in contemporary literature due to limited empirical evidence supporting the matching hypothesis (matching instruction to learning styles does not consistently improve learning outcomes). Thus, this instrument is primarily used to enhance students' self-awareness (metacognition) and provide formative input for application refinement, rather than as a definitive diagnostic tool or basis for broad instructional generalizations.

For transparency and replicability, representative example items from each category (directly adapted and translated from the original questionnaire) are provided: Visual (e.g., Item 1a): "When learning something new, I prefer: a. Seeing pictures, diagrams, or graphs.". Auditory (e.g., Item 1b): "When learning something new, I prefer: b. Listening to explanations or discussions.". Kinesthetic (e.g., Item 1c): "When learning something new, I prefer: c. Doing practice or direct hands-on experience."

The validity of the learning style detection application was assessed by two experts (content and media) using a validation sheet with a 1–4 scale (not valid to very valid). The following are the Media Expert Validation Instrument Grid and the Content Expert Validation Instrument Grid.

Table 1. Media Expert Validation Instrument Grid

No	Statement
A	**Validation Statements** [Likert Scale: 1-4]
1	The learning style detection application functions well without technical issues (e.g., errors or lag).
2	The integration of Google Forms, Sheets, Slides, and Sites operates smoothly and efficiently.
3	The processing of learning style data in Google Sheets is accurate and automated.
4	The learning style detection application is easily accessible across various devices (laptop, tablet, smartphone).
5	The Google Sites interface is clear, intuitive, and user-friendly.
6	Navigation on Google Sites is easily understandable for users (teachers and students).
7	The visual design of Google Sites (color, layout) supports effective information delivery.
8	The learning style detection report in Google Slides is presented neatly and attractively.
9	The application’s response speed (e.g., Google Sites loading time) is adequate.
10	The learning style detection application has a consistent design across all components (Forms, Sites, Slides).
B	**Comments and Suggestions** [Long Text Response]
11	Comments on the strengths of the technology and design aspects of the learning style detection application.
12	Suggestions for improving the technology and design aspects of the learning style detection application.

Table 2. Content Expert Validation Instrument Grid

No	Statement
A	**Validation Statements** [Likert Scale: 1-4]
1	The questions in the learning style detection questionnaire (Google Forms) are clear and easy to understand.
2	The questionnaire items align with the indicators of visual, auditory, and kinesthetic learning styles.
3	The questionnaire can accurately identify students' learning styles.
4	The questionnaire structure supports the collection of valid data for pedagogical analysis.
5	The recommended teaching strategies from the learning style detection align with students' learning styles.
6	The recommendations support the implementation of differentiated learning in the classroom.
7	The recommended teaching strategies are relevant to the goals of the Kurikulum Merdeka.
8	The content of the report in Google Slides provides clear pedagogical information.
9	The learning style detection application supports personalized, student-centered learning.
10	The instruments in the learning style detection (e.g., questionnaire) align with high school learning principles.
B	**Comments and Suggestions** [Long Text Response]
11	Comments on the strengths of the pedagogical aspects of the learning style detection.
12	Suggestions for improving the pedagogical aspects of the learning style detection.

The validation scores were analyzed using Aiken's V formula to determine the level of validity:

$$V = \frac{s}{n(c-1)} \qquad (1)$$

where $s = \Sigma\ (r - l)$, (r) is the assessment score, (l) is the lowest score, (n) is the number of assessors, and (c) is the number of categories. The validity criteria used are high validity ($V > 0.75$), moderate validity ($0.60 \leq V \leq 0.75$), and low validity ($V < 0.60$).

The effectiveness score of the application was measured based on a user satisfaction questionnaire analyzed descriptively through an engagement questionnaire covering aspects of participation, motivation, and interaction in learning, using a Likert scale from 1 to 5 (1 = Very Dissatisfied, 2 = Dissatisfied, 3 = Moderately Satisfied, 4 = Satisfied, 5 = Very Satisfied). The following is the effectiveness instrument grid of the learning style detection application.

Table 3. Effectiveness Instrument Grid of the Learning Style Detection Application

No	Statement
A	**Ease of Use** [Likert Scale: 1–5]
1	I find it easy to access the learning style detection application through Google Workspace.
2	The process of filling out the learning style questionnaire on Google Forms is clear and easy to understand.
3	I can use the learning style detection application without technical difficulties.
4	The user guide for the learning style detection application is easy to follow.
B	**Interface Clarity** [Likert Scale: 1–5]

5	The interface of the learning style detection application (Google Sites) is clear and attractive.
6	The learning style detection results displayed in the application are easy to understand.
7	The information in the learning style detection application (e.g., reports on Google Slides) is presented neatly.
8	Navigation in the learning style detection application (e.g., menus on Google Sites) is easy to use.
C	**Relevance of Recommendations** [Likert Scale: 1–5]
9	The recommended learning strategies from the learning style detection application align with my learning style.
10	The learning style detection application helps me understand my learning style better.
11	The recommendations from the learning style detection application are relevant for improving classroom learning.
D	**Application Benefits** [Likert Scale: 1–5]
12	The learning style detection application helps increase my engagement in learning.
13	The learning style detection application supports differentiated learning in the classroom.
14	I feel the learning style detection application provides tangible benefits in the learning process.
15	I want to continue using the learning style detection application to support future learning.

The effectiveness score of the application is obtained by calculating the average score and the percentage of user satisfaction. The effectiveness criteria used are very effective (81–100%), effective (61–80%), moderate (41–60%), and less effective (<40%).

The student engagement scores before (pretest) and after (posttest) the implementation of the learning style detection are measured through an engagement questionnaire covering aspects of participation, motivation, and interaction in learning, using a Likert scale from 1 to 5 (1 = Strongly Disagree, 2 = Disagree, 3 = Moderately Agree, 4 = Agree, 5 = Strongly Agree). The following is the grid for the engagement instrument before and after the implementation of the learning style detection application.

Table 4. Student Engagement Instrument Grid

No	Statement
A	**Participation** [Likert Scale: 1–5]
1	I actively ask questions or share opinions during classroom lessons.
2	I frequently participate in group or class discussions.
3	I complete class tasks or activities with enthusiasm.
4	I follow the teacher's instructions attentively during lessons.
5	I feel engaged in the learning activities conducted in the classroom.
B	**Motivation** [Likert Scale: 1–5]
6	I feel motivated to learn the subject matter taught.
7	I am interested in the way the teacher delivers the lesson.
8	I have a desire to learn more about the topics taught.
9	I feel happy attending lessons in the classroom.
10	I feel that the teaching methods used make me want to keep learning.
C	**Interaction** [Likert Scale: 1–5]
11	I often interact with classmates to discuss lesson material.
12	I feel comfortable asking the teacher about material I don't understand.

13 I collaborate well with peers in group activities.
14 I feel supported by the teacher to actively participate in class.
15 I feel that classroom learning encourages me to communicate with peers or the teacher.

The pretest and posttest data were analyzed using the N-Gain test to measure the improvement in student engagement. The N-Gain formula is:

$$g = \frac{\text{posttest score} - \text{pretest score}}{\text{maximum score} - \text{pretest score}} \quad (2)$$

The N-Gain criteria used are high ($g \geq 0.7$), moderate ($0.3 \leq g < 0.7$), and low ($g < 0.3$).

RESULTS & DISCUSSION

Result

The results of the learning style detection for Class XI Package A at SMAN 1 Bantaran in this study are presented in Table 5 below.

Table 5. Learning Style Detection Results for Class XI Package A

Learning Style	Male	Female	Amount
Visual	2	1	3
Auditory	7	1	8
Kinesthetic	2	1	3
Total	**11**	**3**	**14**

Table 5 shows the distribution of learning styles among Class XI Package A students, with the majority having an auditory learning style (8 students), followed by visual (3 students) and kinesthetic (3 students). This composition reflects the variety of learning styles that need to be considered in differentiated learning.

This study produced data reflecting the validity, effectiveness, and improvement in student engagement using the Google Workspace-based learning style detection application at SMAN 1 Bantaran. The research results related to validity, effectiveness, and improvement in student engagement are presented in the following tables:

Table 6. Application Validation by Experts

Validation	Assessment Score	Aiken's V Score	Criteria
Media Expert	4.6	0.9	High Validity
Content Expert	4.8	0.95	High Validity
Total	**4.7**	**0.925**	**High Validity**

Table 6 shows that the application validation achieved an average score of 4.7 from media and content experts, with an Aiken's V index of 0.925, indicating that the application is high validity for use in an educational context.

Table 7. Application Effectiveness

Application Effectiveness	Average Score	Percentage	Criteria
Ease of Use	4.48	89.52	Very Effective
Interface Clarity	4.43	89.57	Very Effective

Application Effectiveness	Average Score	Percentage	Criteria
Relevance of Recommendations	4.29	85.71	Very Effective
Manfaat Aplikasi	4.40	88.10	Very Effective
Total	**4.40**	**87.98**	**Very Effective**

Tabel 7 shows that the application was rated very effective with an average user satisfaction percentage of 87.98%, supported by an average score of 4.40 across aspects such as ease of use, interface clarity, relevance of recommendations, and application benefits.

Table 8. Student Engagement

Student Engagement	Pre-Test Average Score	Post-Test Average Score	Percentage Increase	N-Gain	Criteria
Participation	3.97	4.26	7.19	0.28	Low
Motivation	3.87	4.34	12.18	0.42	Moderate
Interaction	3.90	4.43	13.55	0.48	Moderate
Total	**3.91**	**4.34**	**10.95**	**0.39**	**Moderate**

Table 8 shows that student engagement increased from an average pretest score of 3.91 to a posttest score of 4.34, with an overall increase of 10.95% and an average N-Gain of 0.39 (moderate category). The largest increase was observed in interaction (13.55%).

The results of the study indicate that the learning style distribution among Class XI Package A students showed 3 kinesthetic students, 8 auditory students, and 3 visual students. The learning style detection application demonstrated high validity with an Aiken's V index of 0.925, based on assessments from media experts (score of 4.6) and content experts (score of 4.8). The application's effectiveness reached 87.98% based on the user satisfaction questionnaire, falling into the very effective category. Student engagement increased from an average pretest average score of 3.91 to a posttest average score of 4.34, with an N-Gain of 0.39 (moderate category) and a percentage increase of 10.95%.

Built on Google Sites, this learning style detection application helps students identify their learning preferences independently while enabling educators to efficiently evaluate results. The website consists of three main pages. The Home page introduces learning styles and provides links to two key features: the Learning Style Detection Test and Results pages. On the Test page, users complete a self-assessment via Google Forms to discover their preferred learning methods. Additionally, the Results page displays a summary of responses in Google Sheets and offers individualized PDF reports generated from a Google Slides template. With its user-friendly interface and seamless integration of Google tools, this platform provides a practical solution for personalized learning.

Figure 1. Home page

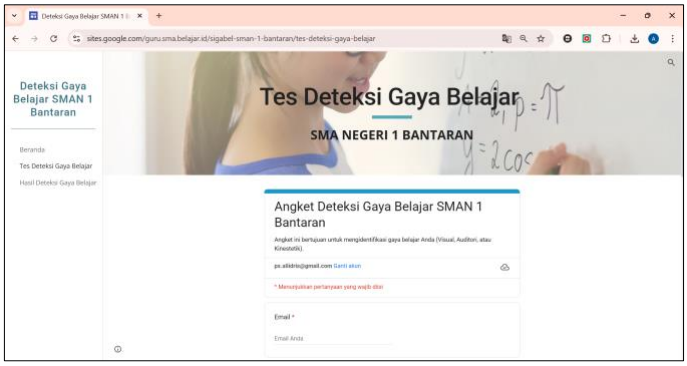

Figure 2. Learning Style Detection Test page

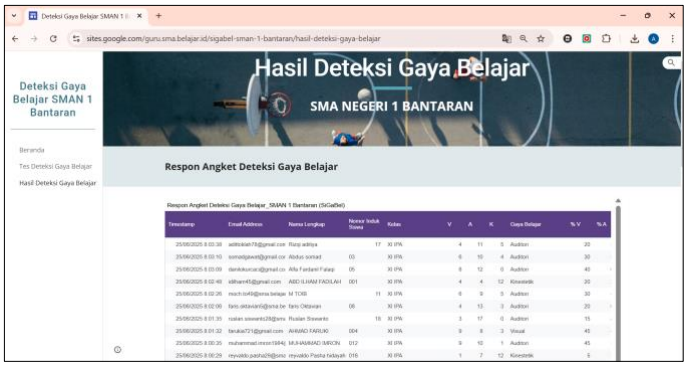

Figure 3. Learning Style Detection Result page

Discussion

Based on the learning style detection results in Table 5, it is evident that the auditory learning style dominates in Class XI Package A, with 8 students (57.1%), while the visual and kinesthetic learning styles are each represented by 3 students (21.4%). This indicates that the majority of students more easily absorb information through auditory means, such as oral explanations, discussions, or audio materials. On the other hand, students with a visual learning style tend to learn more effectively with the aid of images, diagrams, or written materials, while kinesthetic students require physical activities or hands-on practice to understand the material. Gender-based analysis shows that male students (11 students) predominantly have

an auditory learning style (7 students) compared to visual (2 students) and kinesthetic (2 students), while female students (3 students) exhibit a more even distribution, with 1 student for each learning style. This difference may be influenced by factors such as cognitive tendencies, interests, or prior learning experiences. However, due to the relatively small sample of female students (only 3 students), further research is needed to confirm the consistency of this pattern in a larger population. These findings have significant implications for designing differentiated learning in Class XI Package A. For the dominant auditory style, teachers can emphasize discussions, oral explanations, educational podcasts, or recorded materials, and apply techniques such as mnemonics, debates, or storytelling. For visual learners, the use of infographics, flowcharts, animated videos, and colorful notes will be highly beneficial, with an emphasis on visually appealing material presentation. Meanwhile, learning for kinesthetic students should involve simulations, experiments, role-playing, or project-based learning, while accommodating their need for physical movement. These results highlight that, despite the dominance of the auditory learning style, the existing variety of learning styles requires serious attention. A multimodal approach combining visual, auditory, and kinesthetic elements can be an optimal solution to ensure all students are actively engaged in learning. Additionally, teachers are recommended to conduct periodic assessments to monitor the development and changes in students' learning style preferences over time.

The validation results of the learning style detection application indicate excellent quality based on expert assessments. The data in Table 6 reveal that the application achieved an average score of 4.7 out of a maximum of 5, with specific ratings of 4.6 from the media expert and 4.8 from the content expert. The Aiken's V index of 0.925 (on a 0–1 scale) further confirms the high validity of the application, far exceeding the minimum validity threshold of 0.75. Both experts agreed to assign a "High Validity" rating for both media and content aspects, indicating that the application meets quality standards in terms of academic content, interface design, and relevance to learning objectives. This superior validity not only ensures the application's suitability for use in the teaching and learning process but also demonstrates its potential to effectively support the achievement of educational goals.

The data in Table 7 reveal that the learning style detection application received a "Very Effective" rating from users, with an average score of 4.40 (87.98%) on a scale of 5. The ease of use aspect scored the highest at 4.48 (89.52%), followed by interface clarity at 4.43 (89.57%), application benefits at 4.40 (88.10%), and recommendation relevance at 4.29 (85.71%). The high scores in ease of use and interface clarity indicate that the application's design successfully created an intuitive and user-friendly experience. The consistently high scores in benefits and recommendation relevance demonstrate that the content provided is truly useful and aligns with users' learning needs. The consistent "Very Effective" rating across all evaluated aspects not only reflects the application's superior quality but also confirms the alignment between prior expert assessments and real-world user experiences. These findings further solidify the application's position as an effective and viable learning support tool for broader implementation.

Encouraging progress is shown in the evaluation results of student

engagement following the implementation of the learning style detection application. Based on the collected data in Table 8, there was a significant improvement in various aspects of student engagement. The average score increased from 3.91 to 4.34, with an overall growth of 10.95%. This improvement falls into the moderate category according to the N-Gain score (0.39). The interaction aspect among students recorded the most encouraging progress, with a growth of 13.55%, followed by learning motivation, which increased by 12.18%. However, active student participation still requires special attention, as it only recorded a 7.19% increase. These findings reveal that the learning application successfully created a more interactive and motivating learning environment. Students appeared more enthusiastic in engaging with learning materials and interacting with peers. Nevertheless, challenges remain in encouraging consistent active participation among all students. Factors that may have influenced these results include the adaptation period to new digital technology, differences in learning styles, and the need for a more personalized approach. Moving forward, the development of collaborative features and a more responsive feedback system could be solutions to enhance student participation. Overall, these findings provide a positive outlook on the potential of the learning application to improve student engagement. Although there is still room for improvement, the progress achieved indicates a step in the right direction toward creating a more engaging and effective learning experience.

Based on all the findings described, it can be concluded that the learning style detection application has proven effective in enhancing the quality of learning in Class XI Package A. The high validity based on expert assessments (score of 4.7; Aiken's V of 0.925) is supported by very effective usage (score of 4.4; 87.98%) and moderate improvement in student engagement (N-Gain of 0.39). Although the majority of students have an auditory learning style (57.1%), the multimodal approach applied through this application successfully accommodated the needs of all students with various learning styles. The application's success in improving interaction (13.55%) and learning motivation (12.18%) provides concrete evidence of its benefits, although active participation still needs improvement (7.19%). These findings not only demonstrate the application's alignment with modern learning needs that integrate technology but also open opportunities for further development, particularly in strengthening collaborative and personalized learning features to achieve more optimal results in the future.

CONCLUSION

The Google Workspace-based learning style detection application is highly valid (4.7/5, Aiken's V 0.925) and very effective (4.40/5, 87.98%) in enhancing student engagement in differentiated learning at SMAN 1 Bantaran. It moderately improved engagement by 10.95% (N-Gain 0.39, moderate), with interaction (13.55%) and motivation (12.18%) showing the highest gains, though participation (7.19%) needs further improvement. The application effectively accommodates diverse learning styles—auditory (57.1%, 8 students), visual (21.4%, 3 students), and kinesthetic (21.4%, 3 students)—through a multimodal approach. Teachers are

recommended to use tailored strategies (e.g., discussions for auditory, infographics for visual, simulations for kinesthetic learners) and conduct periodic assessments to monitor evolving preferences. Future research should enhance interactive features and test the application on larger, diverse populations to ensure scalability. This application is a valuable tool for modern, technology-integrated education, with potential for broader adoption.

In summary, this study provides a foundational step towards a scalable, technology-assisted approach to differentiation. The developed prototype shows significant potential, but its broader impact and generalizability require further empirical investigation through more extensive and controlled research.

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