



Development of a Mobile Learning Medium with a Project-Based Learning Model for the Competency Unit in Fashion Decoration

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Abstract

Learning ribbon embroidery in vocational fashion programs is difficult because it requires visual demonstration and repeated practice, while teachers often rely on static slides. This research and development study produced and tested a mobile learning medium integrated with a project-based learning (PjBL) model for the fashion decoration competency unit. The ADDIE model guided development at a state vocational high school in Central Java, Indonesia. Three material experts and three media experts evaluated feasibility, five teachers and 26 students evaluated practicality, and a quasi-experimental pretest-posttest control group design (experimental $n = 26$; control $n = 27$) examined effectiveness. Experts rated the medium very feasible (material $M = 4.59$; media $M = 4.45$). Practicality was very high (97%; $K_r = .97$ and $K_s = .93$ for students). The experimental class outperformed the control class on the posttest ($M = 82.50$ vs. $M = 73.52$), $t(51) = 4.67$, $p < .001$, $d = 1.28$, and showed a higher normalized gain (.50 vs. .34), with 96.15% of students reaching mastery. The medium is feasible, practical, and effective for improving cognitive learning outcomes, although psychomotor outcomes still need testing.

Keywords: Mobile Learning, Project-Based Learning, Ribbon Embroidery, Vocational Education, ADDIE



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INTRODUCTION

Digital technology has changed how learning is organized, delivered, and experienced. Mobile devices allow students to reach learning resources at any time and in any place, which supports flexible and self-directed study (Crompton, 2013). A meta-analysis of experimental studies reported that integrating mobile devices into teaching and learning had a positive overall effect on students' learning performance (Sung et al., 2016), and a systematic review of inquiry-based mobile learning in secondary science education highlights the pedagogical potential of mobile technology (Liu et al., 2021). In Indonesia, Android-based media have attracted particular attention because they can combine text, images, animation, and video in one portable package. Such media can be replayed whenever needed, make abstract concepts more concrete, and support motivation and cognitive learning outcomes (Darwin et al., 2023; Rahmah & Hadi, 2023). Vocational education prepares students for work through competence-based learning in which knowledge and practical skills must develop together. Procedural and visual skills are difficult to teach through verbal explanation alone, so digital media that visualize work steps and allow repetition have been developed for several vocational subjects. Examples include an Android-based learning module with a project orientation for computer numerical control machining (Pratama et al., 2024) and a review of Android-based mobile learning media for basic electronics (Widodo et al., 2022).

Fashion education is also highly visual. In the Indonesian Merdeka Curriculum, the Fashion Design and Production subject in Phase F includes an element on textile experimentation and decorative design, in which Grade XI students learn to apply decorative

designs through embroidery. Ribbon embroidery belongs to the group of colored embroidery techniques (Untari et al., 2023) and is used to decorate garments with flowers, leaves, and other motifs (Suwasana & Annisa, 2023). Students need to see exactly how the ribbon is guided through the fabric and need to practice many times before the result looks neat and aesthetically pleasing. Several studies show that digital media can help in this area. A tutorial video on ribbon embroidery developed for a vocational school in Gresik was rated feasible by experts (mean = 3.35), and 94% of students responded positively (Listyani et al., 2024). An Android medium for fantasy embroidery, built with Smart Apps Creator, was judged very feasible by material experts (92%) and media experts (91%), and student responses reached 98.5% (Rambe et al., 2020). A mobile application has also been developed for teaching pattern making in fashion design (İnci & Çileroğlu, 2025), and a smartphone-based training system has been used to teach fashion and textile concepts to students with severe hearing impairment (Salem & Basaffar, 2024).

Learning to embroider is ultimately learning to make a product. PjBL organizes learning around a meaningful project that results in a tangible artifact (Thomas, 2000). It is widely used in Indonesian vocational schools. A study of 15 vocational schools in Java that implemented the Merdeka Curriculum found that PjBL was the dominant approach among fashion teachers, and 78% of the teachers judged it effective for raising motivation and relevance to the workplace, although limited preparation time and a lack of teaching modules were obstacles (Supriyadi et al., 2023). In industrial garment construction, the mean skill score rose from 74.2 to 83.6 after PjBL was applied (Wulandari & Maghfiroh, 2023). PjBL has also been associated with better conceptual understanding (Ardianti & Raida, 2022) and has been combined with digital platforms, for example website-based media for computer network subjects (Kusumawati & Prapanca, 2023) and technology-based PjBL in junior secondary school (Yuspa & Azizah, 2025).

A preliminary study at SMK Negeri 1 Tuntang showed that these elements were not yet combined in the teaching of ribbon embroidery. In a questionnaire and interviews, 68.7% of Grade XI fashion students said they found it difficult to complete the ribbon embroidery project. According to the productive-subject teacher, only 8 of 29 students submitted the project on time. Teaching relied on verbal explanation, demonstrations, and static images in PowerPoint slides. The department owned one projector, and school Wi-Fi was limited. Students therefore lacked a self-access resource that explained the work steps in detail, which hindered their independence and the progress of their projects. Previous media for fashion decoration were mostly e-modules, video tutorials, or stand-alone software, and they rarely combined mobile access with a systematic project-based structure. This is the research gap addressed here. The present study developed a mobile learning medium integrated with PjBL for the ribbon embroidery unit and examined it through four questions. First, how can the medium be designed and developed so that it meets the requirements of a learning medium? Second, how feasible is it according to material and media experts? Third, how practical is it according to teachers and students? Fourth, how effective is it in improving students' learning outcomes compared with conventional instruction? The study contributes by focusing on a fine psychomotor craft competence, which has received less attention in mobile learning research than cognitive subjects, and by placing project tasks and submission features inside the application itself.

RESEARCH METHODS

Research Design

This study used a research and development (R&D) approach with the ADDIE model, which consists of analysis, design, development, implementation, and evaluation (Rayanto,

2020). R&D was appropriate because the aim was not only to produce a medium but also to test its feasibility, practicality, and effectiveness. The effectiveness test used a quasi-experimental pretest-posttest control group design. One intact class used the developed medium, and another intact class received conventional instruction supported by a printed manual book.

Setting and Participants

The study took place at SMK Negeri 1 Tuntang, Central Java, in the Fashion Design and Production program, which implements the Merdeka Curriculum. Two intact Grade XI classes participated: XI Busana 1 as the experimental class ($n = 26$) and XI Busana 2 as the control class ($n = 27$ in the analysis). Random assignment of individual students was not possible because classes were already formed. Six experts validated the product. The three media experts were an instructional technology developer from a provincial education technology unit, a university lecturer, and a visual communication design teacher. The three material experts were teachers of Fashion Design and Production from two vocational schools. Five productive-subject teachers and the 26 experimental students evaluated practicality after using the medium.

Development Procedure

In the analysis stage, the researcher examined the curriculum, teaching materials, supporting facilities, teacher needs, and student characteristics through observation, interviews with the productive-subject teacher, and a questionnaire distributed through Google Forms. In the design stage, the researcher specified the product, mapped its navigation structure, and prepared a flowchart and storyboard (Kusumawati & Prapanca, 2023). In the development stage, the application was built with Kodular and exported as an Android package (.apk). It combined text, images, and links to tutorial videos. Experts then validated the product, and the researcher revised it according to their comments. In the implementation stage, the experimental class used the application in three learning sessions after the pretest, while the control class continued with conventional instruction. The learning in the experimental class followed six PjBL phases: an essential question, project planning, scheduling, project execution and monitoring, assessment of the result, and reflection. In the evaluation stage, formative feedback was gathered at each stage, and learning outcomes were analyzed after the posttest.

Instruments

Three kinds of instruments were used. The first was a pair of expert validation sheets with a five-point Likert scale (1 = very infeasible, 5 = very feasible). The material sheet contained 20 items, 14 on the learning aspect and 6 on subject substance. The media sheet contained 20 items, 3 on general aspects, 9 on software engineering, and 8 on visual communication. Both sheets were adapted from national standard-based instruments used in earlier studies (Arum, 2023; Witdarsih, 2025). The second instrument was a practicality questionnaire with 20 items covering software engineering, visual communication, and instructional design. Respondents answered 1 (practical) or 0 (not practical). The third instrument was a learning test of 20 multiple-choice items on basic ribbon embroidery stitches and on the Japanese and French ribbon embroidery techniques. The same items were used as pretest and posttest. The test was consulted with the supervising lecturer and the subject teacher, and the practicality and test instruments were tried out at another vocational school before use.

Data Analysis

Expert judgments were analyzed with the content validity ratio (CVR), calculated as $CVR = (Ne - N/2)/(N/2)$, where Ne is the number of experts who judged an item appropriate and N

is the total number of experts (Lawshe, 1975). With six experts, the minimum CVR was .672. The content validity index (CVI) was the mean CVR, and values of .68 to 1.00 were categorized as very appropriate. Reliability was expressed as the percentage of agreement (PoA), with a value of at least 80% considered reliable. Mean scores were interpreted as very feasible (4.21 to 5.00), feasible (3.41 to 4.20), fairly feasible (2.61 to 3.40), not feasible (1.81 to 2.60), or very infeasible (1.80 or lower). Practicality was analyzed with the coefficient of reproducibility ($Kr = 1 - e/n$) and the coefficient of scalability ($Ks = 1 - e/k$), where e is the number of errors. The medium was considered practical when Kr was at least .90 and Ks was at least .60. Cronbach's alpha was used for reliability, and the percentage of positive responses was also reported. Effectiveness was analyzed with SPSS. Normality was tested with the Shapiro-Wilk test and homogeneity of variance with Levene's test. Differences between the two classes were tested with an independent-samples t -test at a significance level of .05. Normalized gain (N-Gain) was calculated as $(\text{posttest} - \text{pretest}) / (100 - \text{pretest})$ and categorized as low (below .30), moderate (.30 to .69), or high (.70 or above) (Hake, 1998). Mastery was defined as a posttest score of at least 75, the minimum criterion of learning objective achievement. Cohen's d was calculated from the posttest means and standard deviations (Cohen, 1988).

Review of Literature

Table 1. Previous Studies on Digital Media and Project-Based Learning in Fashion and Vocational Education

No.	Author(s) and year	Context	Medium or approach	Main findings	Difference from the present study
1	Rambe et al. (2020)	Clothing decoration (fantasy embroidery), Grade XI, vocational school in Lubuk Pakam	Android-based medium built with Smart Apps Creator	Very feasible: 92% (material experts) and 91% (media experts); student response 98.5%	No project-based learning model; no task submission feature; effectiveness against a control class not reported
2	Listyani et al. (2024)	Ribbon embroidery, decorative design element, vocational school in Gresik	Tutorial video, R&D with the 4D model	Feasible (expert mean = 3.35); student response 94%	Video format is not interactive; no mobile application; no project structure
3	İnci & Çileroğlu (2025)	Pattern making (dart manipulation and basic pattern), fashion design students	Mobile learning application	Judged effective because step-by-step simulations can be repeated independently	Targets pattern making, not decoration; no project-based learning model
4	Salem & Basaffar (2024)	Fashion and textile concepts, female students with severe hearing impairment	Smartphone-based training system	Image and video visualization compensated for limited verbal communication	Special-needs context; focuses on concepts, not a craft project
5	Supriyadi et al. (2023)	Fashion subjects, 15 vocational schools in Java under the Merdeka Curriculum	Project-based learning (teacher survey)	PjBL was the dominant approach; 78% of teachers found it effective; obstacles were limited preparation time and a lack of teaching modules	Describes teachers' practice; no digital medium was developed
6	Wulandari & Maghfiroh (2023)	Industrial apparel, vocational schools in Yogyakarta	Project-based learning under the Merdeka Curriculum	Mean skill score rose from 74.2 to 83.6	Not supported by a mobile medium; no ribbon embroidery content

RESEARCH RESULTS AND DISCUSSION

Needs Analysis and Product Design

The analysis stage identified five conditions that shaped the product (Table 1). The school used the Merdeka Curriculum, but teaching materials for fashion decoration were still static images on PowerPoint slides, and no mobile learning medium was available. Only one projector was available for the department, and the school's Wi-Fi was limited, so slide-based teaching could not be used flexibly. Learning was centered on the teacher, and teachers asked for media that would help students understand decoration techniques. Students found ribbon embroidery demanding because it requires an in-depth understanding of the stitching process, and records from the previous year showed that many students had not completed their assignments.

Table 2. Summary of Needs Analysis Findings

Aspect	Condition found
Curriculum	Merdeka Curriculum applied through the school's operational curriculum
Teaching materials	Static images on PowerPoint slides; no mobile learning medium
Supporting facilities	One projector in the department; limited school Wi-Fi
Teachers	Teacher-centered learning; media needed to support understanding of decoration techniques
Students	Ribbon embroidery requires deep understanding of technique; explanation alone was insufficient; many assignments not completed in the previous year

Note. Data were obtained from observation, interviews, and document study at SMK Negeri 1 Tuntang

These findings guided the design. The medium was specified as an Android application that runs on devices with Android 8.1 or higher and on computers with Windows 10, with an installation size of about 10 MB. Students can upload project evidence as photos, videos, or reports of up to 500 KB per file. The main menu offers a profile, usage instructions, learning materials, an inspiration gallery, and a task menu with project upload. The material menu covers basic stitches, decorative patterns, and Japanese and French ribbon embroidery, each with a tutorial video link. PjBL is built into the medium through the task menu and the project submission feature, so students receive instructions, practice the technique, and submit their work in the same place. This design reflects the visual and procedural nature of ribbon embroidery. Mobile learning supports study through images, demonstration videos, and steps that can be revisited (Crompton, 2013), and the combination of verbal and visual information follows the principles of multimedia learning (Mayer, 2005). The project structure follows the idea that learning is organized around products (Thomas, 2000). The decision to place all resources in one application also responds to the problem of limited projectors and uneven network access, because students can use their own devices at school or at home. Similar combinations of media and project orientation have been reported for Android-based modules in vocational machining (Pratama et al., 2024) and for ribbon and fantasy embroidery media (Listyani et al., 2024; Rambe et al., 2020). The present design differs from those studies in that tasks and submission are part of the medium and not a separate activity.

Development, Expert Validation, and Revision

The experts' written comments led to four groups of revisions. The first concerned visual design. Experts asked for illustrations that match the fashion theme, such as ribbon flowers, needles, fabric, and thread, a warmer palette (purple with pastel pink, cream, or peach), a visual that is stronger than text alone, fewer empty areas, a small badge that identifies the material,

and friendlier wording that tells students what they will be able to do after learning. The second concerned navigation: header menus should stay hidden until students enter the main menu, and non-functional social media links should be removed. The third concerned teacher functions: an edit menu with a revision log so that students know the latest instruction, a delete function for tasks, zoom for image attachments, a corrected logo, and an active password reset. The fourth concerned submission: PDF files should be accepted for long reports, students should be reminded to set video or cloud links to public, and the success message should include words of appreciation. These comments show that the experts saw the medium's educational structure as sound but wanted its visual identity and administrative features to be stronger. Because fashion is a visual discipline, visual coherence is not decoration alone, since it determines whether students can quickly find and understand the demonstrated steps (Mayer, 2005). The requests for edit, delete, and logging functions indicate that teachers need to manage tasks as the project proceeds, which is consistent with the practical demands of PjBL reported by teachers elsewhere (Supriyadi et al., 2023).

Feasibility of the Medium

All six experts judged the medium very feasible (Table 2). The material experts gave a mean of 4.59, with 4.57 for the learning aspect and 4.61 for subject substance. The media experts gave a mean of 4.45, with 4.44 for general aspects, 4.48 for software engineering, and 4.42 for visual communication. The total scores from the individual experts ranged from 82 to 97 out of 100 for material and from 77 to 97 out of 100 for media. Content validity was also satisfactory: CVI was .90 for material and .80 for media, both within the very appropriate range of .68 to 1.00, and the percentage of agreement was 95% and 92%, both above the 80% criterion. Of 60 item-level judgments from the material experts, 57 were favorable, and the media experts gave 55 favorable judgments out of 60.

Table 3. Expert Validation Results for the Mobile Learning Medium

Expert group and aspect	Items	Expert 1	Expert 2	Expert 3	<i>M</i>	Category
Material: learning	14	4.79	4.14	4.79	4.57	Very feasible
Material: substance	6	5.00	4.00	4.83	4.61	Very feasible
Material overall	20				4.59	Very feasible
Media: general	3	4.00	4.33	5.00	4.44	Very feasible
Media: software engineering	9	4.22	4.56	4.67	4.48	Very feasible
Media: visual communication	8	3.38	4.88	5.00	4.42	Very feasible
Media overall	20				4.45	Very feasible

Note. Material experts: CVI = .90, percentage of agreement = 95%. Media experts: CVI = .80, percentage of agreement = 92%. Scores use a five-point scale

The lowest single rating came from one media expert, who gave 3.38 for visual communication, which falls in the feasible category and not in the very feasible one. This lower rating matches the content of the revision requests, which focused on illustrations, color, and layout. It suggests that the visual layer was the least mature part of the first prototype and that the revisions were justified. Overall, the finding agrees with earlier studies that Android-based and video-based media for embroidery were judged feasible to very feasible (Listyani et al., 2024; Rambe et al., 2020). It also indicates that the medium meets the content requirements of the curriculum, since the material experts rated the alignment of objectives, sequence, examples, and exercises highly. The result should nevertheless be read with care because each expert group had only three members, and expert judgment shows the potential for use and not the actual learning effect.

Practicality of the Medium

Students and teachers both found the medium very practical (Table 3). Students gave positive responses to 504 of 520 possible responses (97%), with $Kr = .97$ and $Ks = .93$, and the teachers gave 97 of 100 (97%), with $Kr = .97$ and $Ks = .94$. All coefficients were well above the required values of .90 for Kr and .60 for Ks . The student questionnaire also had a Cronbach's alpha of .818, indicating high internal consistency. Negative responses were concentrated in two items: Items 5 and 6 accounted for 14 of the 16 negative student responses and for all three negative teacher responses.

Table 4. Practicality Results from Students and Teachers

Respondents	<i>n</i>	Items	Positive responses	Practicality (%)	<i>Kr</i>	<i>Ks</i>	Cronbach's α
Students	26	20	504 of 520	97	.97	.93	.818
Teachers	5	20	97 of 100	97	.97	.94	n/a

Note. The medium is practical if $Kr \geq .90$ and $Ks \geq .60$. Number of negative responses: students = 16, teachers = 3. n/a = not applicable

The high practicality is consistent with the features students used during learning: materials, instructions, tutorial videos, an inspiration gallery, tasks, and project upload, all reachable from one menu. This arrangement reduces the effort needed to find resources, which is a central argument for mobile learning (Crompton, 2013), and it is in line with the high student responses reported for Android media on embroidery (Rambe et al., 2020; Listyani et al., 2024). Procedural content such as ribbon embroidery also benefits when students can watch each step as often as needed. Because the application can be installed on students' own phones, it also supports independent study outside the classroom, a benefit reported for Android media that helps students learn on their own and depend less on the teacher's explanation (Rambe et al., 2020). This addresses the dependence on teacher demonstrations that characterized the situation before the study. Three cautions apply. The questionnaire was binary, which gives limited sensitivity and makes ceiling effects likely. Students answered right after using the medium and may have been inclined to answer favorably. Finally, the two items that attracted most of the negative responses point to specific aspects that deserve refinement in later versions, together with the additional features the experts requested. The practicality results therefore show that the medium can be used without major obstacles in this school, but they do not show how it performs under weaker network conditions or in other schools.

Effectiveness of the Medium

Before the treatment, the two classes had similar prior knowledge (Tables 4 and 5). The experimental class averaged 63.08 and the control class 58.70. Levene's test was significant ($p = .010$), so the Welch result was used: $t(38.26) = -1.70$, $p = .097$. The difference of 4.37 points was therefore not statistically significant, and the classes could be compared. After three learning sessions, the experimental class averaged 82.50 ($SD = 7.25$) and the control class 73.52 ($SD = 6.77$). Posttest scores were normally distributed in both classes (Shapiro-Wilk $p = .084$ and .086), and variances were homogeneous (Levene's $p = .500$).

Table 5. Descriptive Statistics of Pretest and Posttest Scores

Test	Group	<i>n</i>	<i>M</i>	<i>SD</i>	Min	Max
Pretest	Experimental	26	63.08	11.58	30	80
Pretest	Control	27	58.70	6.29	45	70
Posttest	Experimental	26	82.50	7.25	70	100
Posttest	Control	27	73.52	6.77	60	90

Note. Posttest Shapiro-Wilk: experimental $W = .931, p = .084$; control $W = .934, p = .086$. Levene's test: pretest $F = 7.217, p = .010$; posttest $F = 0.463, p = .500$. Pretest minimum and maximum values were computed from individual scores.

The independent-samples t -test showed a significant posttest difference of 8.98 points in favor of the experimental class, $t(51) = 4.67, p < .001, 95\% \text{ CI } [5.12, 12.85]$. Cohen's d was 1.28, a large effect by conventional benchmarks. The gap between classes was therefore larger after the treatment than before it, and not a carry-over of the initial difference. The difference also has a practical meaning: with a mastery threshold of 75, the control mean (73.52) fell just below the threshold, whereas the experimental mean exceeded it by 7.5 points. The normalized gain was .50 for the experimental class and .34 for the control class, both in the moderate category, but the gain was higher with the medium. Twenty-five of 26 experimental students (96.15%) reached the mastery criterion of 75, compared with 17 of 27 control students (62.96%).

Table 6. Effectiveness Indicators for the Experimental and Control Classes

Indicator	Experimental	Control	Test result or note
Pretest mean	63.08	58.70	$t(38.26) = -1.70, p = .097$ (Welch)
Posttest mean	82.50	73.52	$t(51) = 4.67, p < .001; d = 1.28$
Mean difference (95% CI)	n/a	n/a	8.98 [5.12, 12.85]
Mean N-Gain	.50	.34	Both moderate
Students with low / moderate / high N-Gain	5 / 17 / 4	10 / 16 / 1	Counts of students
Students reaching mastery (posttest ≥ 75)	25 of 26 (96.15%)	17 of 27 (62.96%)	Mastery rate

Note. CI = confidence interval; n/a = not applicable. Cohen's d was calculated from posttest means and standard deviations. N-Gain categories and the control-class mastery rate were computed from individual scores

Several mechanisms may explain the advantage of the experimental class. The medium let students return to demonstrations and images whenever they needed them, a benefit of mobile and Android-based media noted in reviews (Crompton, 2013; Darwin et al., 2023). Pairing images, words, and video fits the multimedia learning principle (Mayer, 2005). The project tasks gave students a reason to apply what they had learned, in line with constructivist views that knowledge grows through active work on authentic tasks (Thomas, 2000; Vygotsky, 1978). The result is also consistent with studies reporting gains in vocational skills after PjBL (Wulandari & Maghfiroh, 2023) and with the positive overall effect of mobile devices found in meta-analytic work (Sung et al., 2016). It is important, however, to read the control group correctly. It also improved (N-Gain = .34), so conventional instruction with a manual book was not ineffective, and the medium produced an additional improvement and not a first one. The moderate normalized gain also deserves honest interpretation. The effectiveness claim rests mainly on the significant difference between classes, the large effect size, and the high mastery rate, and not on a high gain. Five experimental students had a low gain, among them one student who scored 80 on both tests. Students who already score high have little room to gain, and a few students may need more support than the application can give. The control class also contained two students whose scores fell from pretest to posttest, which shows that individual variation was present in both classes and that average results hide students who need closer monitoring.

Implications and Limitations

For teachers, the medium offers a way to use project-based teaching in a structured form while reducing the time spent repeating demonstrations. Students can revisit the steps on their own devices and submit work through the same application, which may help address the late submission problem that motivated the study. For schools, the results suggest that a low-cost application built with a no-code tool can be a realistic option when projectors and network access are limited. The experts' recommendations also point to future features: evaluation tools, documentation of project progress, and direct feedback to students. Several limitations should be acknowledged. First, intact classes were used, so selection effects cannot be excluded, and the experimental class started slightly higher, although not significantly. The analysis compared posttest scores and gains and did not adjust statistically for pretest differences. Second, the treatment lasted only three sessions, and long-term retention was not measured. Third, the experimental class received the mobile medium and PjBL together, whereas the control class used conventional instruction and a manual book, so the separate contributions of mobile access and project-based structure cannot be isolated. Fourth, effectiveness was measured with a multiple-choice test of cognitive learning outcomes. Although the medium targets a psychomotor competence, the quality of students' embroidery products and their timeliness were not evaluated in the analysis reported here. Fifth, the study took place in one school with a small sample, so generalization should be cautious. Future studies could use randomized or matched designs, include a rubric-based assessment of project products, compare mobile and non-mobile versions of the same PjBL activities, and test the medium in more schools and over a longer period.

CONCLUSION

This study developed a mobile learning medium integrated with project-based learning for the ribbon embroidery unit in fashion decoration, using the ADDIE model. The design, based on a needs analysis, produced an Android application containing materials, tutorial video links, an inspiration gallery, and task and project upload features that meet the curricular requirements and the conditions of the school. Six experts rated the medium very feasible, with mean scores of 4.59 for material and 4.45 for media. Students and teachers rated it very practical, with a practicality percentage of 97% and reproducibility and scalability coefficients far above the criteria. The medium was also effective in improving cognitive learning outcomes. The experimental class scored significantly higher than the control class on the posttest, with a large effect size and a moderate normalized gain that exceeded that of the control class, and nearly all experimental students reached the mastery criterion. These findings support the use of mobile learning combined with PjBL for visual and procedural vocational competencies, where students need repeated access to demonstrations and a clear project structure. The findings are limited by the quasi-experimental design, the short treatment, the single-school sample, and the focus on cognitive outcomes. Taken together, the four research questions were answered positively: the design met the requirements of a learning medium, and the medium was feasible, practical, and effective. Teachers can use the medium as a supplement to face-to-face teaching, and developers can extend it with evaluation features, project progress documentation, and direct feedback. Future research should assess psychomotor outcomes and the quality of embroidery products with a validated rubric, examine retention over a longer period, and test the medium with larger and more diverse groups of students.

The novelty of this study lies in the integration of mobile learning technology with a project-based learning (PjBL) model specifically designed for the ribbon embroidery competency unit in vocational fashion education. Unlike conventional instructional media that

primarily rely on static presentations or provide digital learning materials without an explicit pedagogical framework, the proposed medium combines mobile accessibility with project-oriented learning activities to support students in understanding embroidery concepts and completing structured practical projects. By embedding PjBL into the design of the mobile learning medium, this study extends the application of mobile-assisted learning beyond content delivery toward a more structured learning experience that connects conceptual understanding with authentic vocational tasks. The study further contributes empirical evidence through a development-and-evaluation process that encompasses expert validation, practicality assessment, and a quasi-experimental comparison of learning outcomes. The experimental group achieved a higher posttest mean than the control group (82.50 versus 73.52), with a large between-group effect size (Cohen's $d = 1.28$), indicating a substantial difference in cognitive learning outcomes under the conditions examined. Importantly, the study addresses a specialized competency in fashion decoration that requires visual guidance and repeated practice, thereby providing a context-specific application of technology-enhanced, project-based vocational learning. Its principal contribution is therefore the development and empirical evaluation of a pedagogically integrated mobile learning medium for ribbon embroidery, while also identifying the need for further investigation into psychomotor performance and practical skill transfer. This distinction provides a foundation for future research on the design of mobile learning environments that support both cognitive achievement and practical competency development in vocational education.

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