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Tracing Cognitive Task Demands And Instructional Support In A Developed Educational E-Book: A Theory-Informed Content Analysis

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Abstract

This study examines the relationship between written cognitive task demands and embedded instructional support in a completed higher education e-book on computer-based instruction. The resource was produced through a funded instructional development project using a Four-D Model by Thiagarajan. Directed qualitative content analysis covered seven chapters, 44 learning

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objectives, 30 multiple-choice items, 19 essays, 10 cases, one practical task, and related instructional segments. The analysis compared expected performances with responses required by assessment prompts and examined conceptual, procedural, and evaluative supports relevant to those tasks. The findings show that assessment prompts vary in the scope of performance they elicit. A source-appraisal task combines prescribed search steps with credibility criteria, whereas an AI-tutor assignment links prompt examples and evaluation cues with testing and revision requirements. These relationships indicate that e-book developers may benefit from distinguishing task conditions from resources that support learner decisions. The study offers task-linked considerations for instructional design and development without inferring product effectiveness.

Keywords: Educational e-book; Instructional design; Cognitive task demands; Instructional support; Qualitative content analysis

INTRODUCTION

An educational e-book is more than a digital container for course content. Its instructional character depends on the performances it asks learners to demonstrate and the resources made available for completing those tasks. Studies comparing screen and print reading [1], [2] and investigating university e-textbook use [3], [4] show why the medium alone is an insufficient explanation of learning. A second-order meta-analysis also found heterogeneous effects of technology use across educational contexts [5]. These studies motivate a closer question for Educational Technology: how do the intended performances, assessment demands, and embedded supports relate within a particular learning resource?

This question requires a distinction between a task as specified and a task as carried out. In the present study, written cognitive task demands refer to the kinds of intellectual response made necessary by an assessment prompt, such as explaining a concept, comparing alternatives, appraising evidence, or producing and revising a design. Research on instructional tasks distinguishes demands established in a task from those sustained during classroom enactment [6]. Revised Bloom's taxonomy provides vocabulary for describing the specified cognitive process, not a measure of student effort or cognitive load [7]. Constructive alignment addresses the relationship among intended outcomes, learning activities, and assessment [8]. Our documentary data permit a narrower examination of objective-assessment congruence and the planned activity cues embedded in the resource. Examples and guidance are relevant when they address decisions learners must make, rather than merely appearing near the same topic [9]–[10]. Within

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Educational Technology, this analysis concerns the design and creation of resources intended to facilitate learning, consistent with the field's emphasis on creating, using, and managing appropriate technological processes and resources [11].

Related work has examined relationships among objectives, tasks, and support, but often with a different unit of explanation. Khoirussulfa and Saraswati investigated objective-activity-assessment congruence in a language textbook [12], while Hibaturahim and Farida considered how a textbook's scaffolding related to demanding writing assignments [13]. Lestari and Yusuf examined alignment using classroom evidence as well as documents [14]. Research on digital textbooks has also addressed design features and accessibility, and studies of interactive storybooks have examined how particular features shape learning opportunities [15], [16]. The unresolved issue for the present product is not whether alignment or scaffolding matters. It is how a specified learner response relates to a distinct type of embedded support at the point where that response must be produced. This question moves the analysis beyond counting digital features or treating topical similarity as evidence of congruent performance.

The e-book *Pembelajaran Berbasis Komputer* (PBK; Computer-Based Instruction) offers a bounded case for examining this relationship at the level of individual tasks. This study identifies what the objectives and assessment instructions actually request, distinguishes support material from assessment deliverables, and traces how different supports are positioned alongside those requests. It then develops design considerations grounded in the observed combinations of task and support, rather than offering an additional generic sequence of development stages. Such a situated account complements research showing how instructional development practice can generate practical knowledge [17].

Two research questions guided the analysis: (RQ1) How do stated learning objectives relate to the written cognitive demands of the chapter-end assessment tasks in the PBK e-book? (RQ2) What forms of embedded instructional support relate to those tasks, and what decisions are they positioned to support? The design implications are a theory-informed interpretation of the documentary findings rather than a separate outcome or a new development model.

METHOD

2.1 Research context, design, and corpus

The primary corpus was the completed *Pembelajaran Berbasis Komputer* e-book, prepared in 2026 by Virzha Aulianna Dhaksietsatsura, Mulyadi, and Aprilia Ghifari Faizatun Ni'mah for the Educational Technology Study Program, Faculty of Education, Universitas Negeri Jakarta. This 130-

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page static PDF was a product of a funded instructional development project and is described here as an unpublished research artifact. It contains seven chapters on computer-based learning, learning concepts, instructional models, search engines, artificial intelligence, digital self-branding, and ICT literacy. Its foreword describes a project-based orientation. The project's development context was Four-D, encompassing Define, Design, Develop, and Disseminate [18]. The analysis in this article concerns the completed document, rather than an examination or verification of every stage of that project.

The article employed directed qualitative content analysis of the final document. In this approach, theory and earlier research inform initial analytic categories while the material under study provides the evidence for interpreting them [19]. The corpus covered all seven chapters, including 44 stated objectives and 60 primary chapter-end assessment items. The latter comprised 30 multiple-choice questions, 19 essays, 10 contextual cases, and one task classified as a practical exercise. These are response-format categories, not a hierarchy of cognitive complexity or a count of project-based activities. In-chapter explanations, examples, prompts, and representations were examined as potential supports to the assessment tasks. Document analysis permits examination of these written design features, but not claims about classroom use [20]. The original Indonesian wording, task identifiers, and page locations were retained in a working analysis register.

2.2 Analytical lens and operational distinctions

For RQ1, each learning objective was examined for its action, conceptual object, stated scope, and expected evidence of performance. Assessment items were examined by reading the full prompt, including all subinstructions, and recording the response learners would have to produce. Written cognitive demand was operationalized as this requested response and the reasoning it explicitly calls for, not as a measured mental workload. The analysis compared each objective with relevant prompts and retained distinctions between explicit coverage, partial coverage, and no explicit elicitation in the working register. These labels are traceability decisions for this single corpus, not a standardized alignment score. Where wording was ambiguous, the analysis did not infer a required artifact from an implied action. Bloom's revised taxonomy guided descriptions of cognitive processes [7], while research on instructional tasks informed the distinction between documented task requirements and enacted learning [6].

For RQ2, a feature was treated as instructional support only if it supplied information or guidance that could help a learner understand content, choose a strategy, or judge a response. Three descriptive functions organized the reading: conceptual or representational support

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(explanations and illustrations), procedural or strategic support (steps and examples of possible approaches), and evaluative or metacognitive support (questions or criteria used to inspect a response). These functions are working groupings informed by scaffolding research, not a newly validated typology [21], [22], [23], [24]. A requirement to submit screenshots or perform three trials was classified as an assessment condition; an instruction to revise a prompt was classified as an expected task action. Neither was counted as instructional support unless accompanied by guidance for carrying it out. The presence of preplanned assistance in a static PDF is consistent with embedded or 'hard' scaffolds [24]; adaptation to an individual learner, fading, and the actual use of assistance cannot be inferred from this document. Table 1 illustrates the distinctions used to prevent category overlap.

Table 1. Operational coding distinctions and documentary examples from *Pembelajaran Berbasis Komputer* (PBK).

Analytic distinction	Decision rule	Documentary example (chapter)
Required cognitive performance	Record the response and reasoning explicitly required by the full prompt, without inferring a level from the verb alone.	Chapter 3 asks learners to compare simulation and instructional games.
Task parameter / deliverable	Classify prescribed tools, starting conditions and items to submit as requirements, not instructional help.	Chapter 4 names Google or Bing and a search phrase; Chapter 5 requires screenshots of three trials.
Conceptual / representational support	Identify explanations, diagrams or examples that clarify information or possible formulations relevant to a task.	Chapter 5 presents prompt components and illustrative prompt formulations.
Procedural / strategic support	Identify steps or strategic guidance that helps a learner carry out a task, beyond fixing its starting conditions.	Chapter 4 provides a staged search procedure alongside the source-appraisal activity.
Evaluative / metacognitive support	Identify questions or criteria that help learners inspect, justify or reconsider a response.	Chapter 4 names authorship, date and content relevance; Chapter 5 supplies questions on AI-output quality.

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2.3 Procedure and safeguards against selective interpretation

The first pass inventoried every objective and every chapter-end assessment, including the 30 multiple-choice items. A second pass linked relevant in-chapter support segments to specific task decisions. In the working register, source wording and the location of each item were retained alongside the explanation for a proposed link. Table 1 presents examples for differentiating analytic categories, not findings restricted to the chapters represented in its final column. The examples from Chapters 3–5 make distinctions between task requirements and support cues explicit; the full analysis covered all seven chapters. Cases were chosen for the manuscript to show a range of requested responses, including recognition items, explanatory and comparative essays, guided source appraisal, an artifact-design and revision task, and contextual ethical judgment. The case selection included both narrower objective-task coverage and an explicit performance match. The selected cases illustrate contrasting configurations rather than the prevalence of any configuration across the corpus. Short excerpts are reported in their source language with English interpretation; the complete register remains available for source checking, subject to permission to share the underlying educational product.

An item-level coding register, including source locations and reasons for classification, was retained for research auditing. Sharing the register or underlying unpublished e-book outside the research team is subject to the permissions applicable to the instructional product.

One member of the manuscript research team co-authored the PBK e-book. To address the resulting risk of preferential interpretation, the working register records the exact wording of objectives and tasks, reasons for links, negative and contrasting cases, and changes made after source reinspection. This audit trail supports transparency but is not equivalent to independent coding. No second human coder, expert product validation, learner trial, or classroom implementation is claimed in this article. Its evidence concerns the intended instructional structure visible in the document, not its effectiveness or feasibility in use.

RESULTS AND DISCUSSION

3.1 Different performances are elicited by the chapter-end tasks

The 60 chapter-end items present several response formats. Thirty multiple-choice questions, distributed across six chapters, mainly ask students to select among competing statements, examples, definitions, or model attributes. The remaining 19 essays, 10 cases, and one practical exercise more often require a written explanation, comparison, justification, or planned action. These categories describe the output format, not a guaranteed level of thinking:

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selecting an answer can involve inference, and an essay can be answered by recall. The practical question in Chapter 4 directs learners to search for a source and justify its credibility. In Chapter 5, an essay item contains a more extended design task requiring a tutor prompt, three trial scenarios, screenshot documentation, revision, and a TPACK explanation. The fact that this design task is classified as an essay demonstrates why response-format counts must not be mistaken for counts of project-like learning activities.

The detailed comparison reveals both congruent responses and differences in scope. Chapter 3 states an objective to analyze connections among four computer-based instructional models within a learning cycle, whereas an essay asks learners to 'Bandingkan model simulasi dan instructional games' (compare the simulation and instructional-games models). This is a meaningful comparison, but it does not elicit the full four-model relationship specified in the objective. Chapter 2 likewise includes an instructional communication objective whose complete scope is not directly requested by the teaching-versus-instruction comparison. In Chapter 1, wording about a development sequence ending in a flowchart does not unambiguously demand a drawn flowchart. The analysis therefore records differences in the explicitly required evidence rather than assuming that a diagram is missing.

Chapter 5 provides an instructive contrasting case. An objective asks students to formulate effective prompts, and the concluding assignment requires them to create a tutor prompt and then test and revise it. The instruction explicitly says 'Revisi prompt berdasarkan hasil uji coba' (revise the prompt based on the trial results). It also requires an explanation connecting the design to TPACK, which concerns the interaction of technological, pedagogical, and content knowledge [25]. Here, the task requests an artifact and a justification related to the intended performance. The document specifies evidence learners should produce; it does not include student work through which the quality of that evidence could be assessed.

3.2 Supports are most interpretable when tied to a learner decision

The instructional resources surrounding tasks differ across the seven chapters. Chapters 1–3 primarily provide definitions, comparative explanations, and descriptions of computer-based instructional models as conceptual reference points. Chapters 4–7 also include source-appraisal criteria, prompt-design examples, reflection cycles, and contextual guidance for ethical judgments. The following cases illustrate how these resources relate to distinct task decisions; they are not presented as a ranking of chapter quality.

Chapter 5 illustrates several forms of embedded support serving different purposes. Its

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prompt-component table and illustrative formulations make possible design choices visible. Questions about accuracy, sources, process, and contextual fit provide cues for inspecting AI output. These are support resources. By contrast, the requirement for three trials, screenshots, a revised prompt, and a TPACK explanation specifies the evidence to be submitted. The distinction matters: learners receive examples of how a prompt can be formed, criteria relevant to checking an output, and an assignment that asks them to act on those resources. The document does not display a complete worked example of diagnosing a failed AI response or a record of a student's revisions.

In Chapter 4, the search task combines a constrained starting procedure with cues for judging information quality. Students are told to use Google or Bing and a supplied search phrase. More analytically important is the instruction 'Periksa kredibilitas sumber berdasarkan identitas penulis, tahun terbit, dan kesesuaian isi' (check source credibility using authorship, year of publication, and content relevance). This cue establishes criteria for the appraisal that the task asks students to justify. The named search engine and phrase are task parameters; the credibility indicators serve an evaluative function. The written evidence is therefore best described as guided source appraisal rather than independent search-strategy design.

Chapters 6 and 7 provide further variation. The self-branding chapter represents reflection and adjustment as a recurring process and pairs it with a contextual case. The ICT-literacy chapter presents a group-work scenario requiring attention to information checking, cooperation, privacy, and digital ethics. These segments offer conceptual and contextual reference points rather than the procedure-plus-criteria pattern seen in Chapter 4 or the design-and-revision sequence in Chapter 5. The distinction emerges from the responses requested by the tasks and the information placed around them; it is not a ranking of chapter quality.

The narrower reach of several assessment questions is also important to the interpretation. In Chapter 6, authenticity and consistency are discussed in both the objective and the case, but the case does not explicitly request the whole relationship between those qualities and audience trust. In Chapter 7, the case elicits reasoning about information reliability and ethical action, whereas the associated objective also includes critical thinking, productivity, and collaboration. The questions provide evidence for some dimensions of the intended performance, not necessarily all of them. These selected cases illustrate narrower elicitation of the written objectives. They are reported alongside a more explicit objective-task correspondence in Chapter 5, without implying that either pattern represents a majority of the corpus.

The foreword identifies a project-based orientation, and the Chapter 5 design task

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specifies an artifact, testing, and revision. These are meaningful documentary features. However, neither an end-of-chapter deliverable nor its response-format label can establish the full pedagogical cycle of project-based learning. Investigating the sustained inquiry, collaborative work, and critique experienced by learners would require evidence beyond the final PDF. The present study accordingly treats the project-based description as development context rather than a separate evaluated outcome.

3.3 Interpreting task and support relationships through instructional theory

Constructive alignment offers a reason to ask whether the evidence required by an assessment corresponds to the intended outcome [8]. Because the PBK analysis did not observe enacted learning activities, its immediate finding concerns objective-assessment congruence, informed by alignment theory rather than a demonstration of fully achieved constructive alignment. Chapter 3 illustrates this distinction. Asking learners to compare simulation and instructional games engages relevant knowledge, but it does not request analysis of all four models in a learning cycle. The design issue is therefore the scope of the evidence sought. A reviewer of an e-book can examine whether each intended performance has a corresponding opportunity for the learner to demonstrate it.

The revised Bloom taxonomy describes possible cognitive processes associated with such responses, but the complete wording and expected output matter more than an isolated verb [7]. Research on instructional tasks further cautions against treating written task demands as proof of the demands students experience when the activity is taught [6]. This distinction also applies to the Chapter 5 TPACK component: explaining how content, pedagogy, and technology are combined is a requested justification, not evidence that students have developed a measurable level of TPACK competence [25]. The analysis consequently concentrates on what the written tasks make inspectable.

The tutor-prompt examples illustrate the value of distinguishing the function of an example from the work a learner is expected to complete. Example-based learning research explains why observing a possible solution can guide later problem solving [9]. In PBK, the examples make prompt formulations visible. Evaluation questions then guide attention to different properties of an output, while the assignment requires trials and revisions. The source does not present a full worked example of diagnosing an unsuitable response and deciding on a revision. Its contribution to the present analysis is the combination of several distinct instructional elements around one design task, rather than the simple presence of an example.

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Chapter 4 has a different support configuration. A prescribed search engine and query reduce initial procedural choice; the source-appraisal questions establish a basis for making a credibility judgment. Work on guidance in inquiry learning suggests that supports should be considered in relation to the inquiry task and the judgment expected of the learner [10]. Research on embedded scaffolds similarly distinguishes planned conceptual and strategic resources from assistance supplied responsively during teaching [24]. In the PBK example, guidance is visible in the source, while the learner's actual use of it is not. Aeni, Ni'mah, and colleagues' PICRAT study [26] offers a complementary pedagogical comparison: although their unit of analysis was teachers' reported technology use, both analyses ask what the technology-associated activity requires users to do. For PBK, the relevant demand is evaluating a source, not merely operating a search engine.

In the tutor-design task, screenshot evidence and a requirement to revise specify what students should submit. They do not explain by themselves how a student judges the difference between an intended response and the response produced by the AI. Sadler [27] connects formative assessment with the use of criteria to appraise current work and act on a discrepancy. Nicol and Macfarlane-Dick [28] describe the learner's role in generating and using feedback, while Hattie and Timperley [29] explain how feedback can inform further action. The PBK document contains planned appraisal cues and revision requirements. Whether learners used them effectively remains outside the evidence of this study.

This creates a focused implication for authors of comparable e-books. Since PBK already requires three scenarios and screenshot documentation, recommending another test or screenshot would add little. A short comparison record could instead make the reasoning behind revision more inspectable: the expected output, the observed output, the criterion used to judge the difference, and the rationale for changing the next prompt. This is a prospective authoring consideration. Merrill's principles of demonstration and application help explain why visible examples, opportunities to test a response, and reflective integration should be designed together [30]. The contribution lies in differentiating evidence that a task was completed from evidence explaining the decisions made during it.

3.4 Implications for Design and Develop

The project's Four-D context provides a practical location for these design decisions [18]. During Design, specifying objectives and criterion-referenced tasks requires attention to the particular response that will demonstrate an intended performance. During Develop, explanations, examples, procedural cues, and evaluative prompts are realized within the learning

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resource and can be inspected against the intended responses. The final PBK e-book permits analysis of the resulting relationships. It does not document a completed appraisal or user-testing cycle in the data analyzed here. Accordingly, these are applications of the findings to Four-D authoring decisions, not a retrospective evaluation of all four stages.

A complementary development study by Ni'mah, Cahyani, and Aeni [31] offers a useful comparison. In redesigning a Human Performance Technology MOOC, they related learning needs to modular content and structured activities, and reported evaluations of pedagogical and media feasibility for that separate product. The point of comparison is not that MOOC development used ADDIE while PBK used Four-D. Rather, it is that instructional choices can be examined in terms of the performances, activities, and media resources they organize. The PBK analysis makes this connection at the level of specified e-book tasks and available support, without borrowing the MOOC study's evaluation results as evidence about PBK.

A practical distinction emerges across the cases. The search task places criteria alongside a procedure for judging a source. The tutor-design task places prompt formulations, evaluation questions, test documentation, and revision requirements around an artifact to be produced. These resources are not interchangeable: a formulation example addresses an initial design choice, whereas a credibility cue or evaluation question addresses a later judgment. For a developer working within Four-D, the transferable question is therefore which decision a learner must make at a given task step, and what information the resource supplies for making that decision.

The fixed-format PDF makes examples, procedures, and evaluation questions available in advance, but it cannot itself adapt guidance to an individual response. When designing an interactive e-book, developers could consider whether optional response-dependent prompts or embedded comparison records would clarify decisions during task completion. Such functionality is a prospective extension of the present analysis, not a feature observed or tested in PBK.

Table 2 summarizes the design considerations resulting from those specific task-support relationships. It is included as a concise synthesis for authors of comparable e-books; the empirical observations and interpretive limits remain in the preceding text.

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Table 2. Task-linked design considerations derived from the PBK e-book analysis.

Decision-point question and theory	**PBK evidence and its interpretive meaning**	**Practical use during Four-D Design / Develop**
What learner response would demonstrate the intended performance? [8]	The Chapter 3 objective includes relationships among four instructional models; an essay compares only two of them.	Design: specify the response by which every intended performance will be examined.
Which task conditions are prescribed, and which criteria support a learner judgment? [24]	Chapter 4 prescribes a search engine and phrase, then supplies criteria to judge the resulting source.	Design: decide which choices should be constrained and which judgments learners must justify. Develop: make criteria easy to consult at the decision point.
How can examples and appraisal cues support a reasoned design revision? [9], [27], [28]	Chapter 5 gives prompt formulations and questions about output quality, then requests trials, screenshots, and revisions.	Develop: place models and evaluative cues near the design task. If justified revision is intended, consider a brief comparison of expected output, observed output, criteria and change.
Which conceptual, procedural or evaluative cue is relevant to the decision the task requires? [21], [24]	The contextual cases in Chapters 6 and 7 draw on conceptual and ethical explanations rather than providing complete step-by-step production procedures.	Design and Develop: choose conceptual, procedural or evaluative cues according to the decision a task asks learners to make.

Note. The implications concern decisions an author may examine when developing a similar e-book. They are not validated design criteria.

3.5 Contribution and limitations

This study adds a task-level account of the way written instructional support can be related to the response a learning activity requests. Prior textbook research established the importance

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of objective-assessment relationships [12] and scaffolding for more demanding tasks [13]. The PBK case extends that conversation to a developed digital resource by distinguishing between planned examples, task parameters, appraisal cues, and required deliverables. For instance, specifying a search phrase is not the same as providing criteria for source credibility, and requiring a screenshot is not the same as helping students explain a design revision. This distinction gives developers a more precise way to examine whether the help embedded in a resource addresses the decisions required by its tasks.

The findings are limited to one completed e-book and a document-based, single-analyst interpretation. One manuscript team member co-authored the product, which may influence the reading of its strengths and limitations. The study has no independent coder, documented product validation, student submissions, or classroom observation from which learning outcomes, usability, or implementation quality could be inferred. Its project-based orientation was recorded as contextual intent rather than assessed as enacted PjBL. The internal evidence register makes decisions traceable but does not replace independent verification; subsequent studies could contrast documentary analyses with learner work or classroom use. These boundaries limit the reach of the design considerations without negating the specific relationships observed in the resource.

CONCLUSION

Analysis of the completed PBK e-book shows that written learning tasks call for different evidence and that embedded supports relate to those demands in different ways. Source-appraisal prompts pair a search procedure with credibility criteria, while the AI-tutor assignment connects formulation examples and evaluative cues with testing and revision requirements. The distinction between providing a task condition and supporting the reasoning required to complete it offers a practical consideration for the Design and Develop stages of educational e-book production. The article contributes this bounded, evidence-linked account of instructional design rather than a new or validated development model.

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