

Developing a Word Square Student Worksheet on Animal Classification to Foster the Conceptual Understanding of Grade X Students

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Abstract: Biology instruction on animal classification at SMA Negeri 7 Bengkulu Utara remained dominated by lecture and note-taking, with worksheets consisting of conventional exercises that gave students little opportunity for active engagement. Observation of 32 grade X students found that around 78% were passive during lessons, 72% reported difficulty understanding animal classification, and the mean daily test score reached only 6.8 against a minimum criterion of 7.5. This study aimed to produce a Word Square Student Worksheet (LKS) on animal classification that is valid and practical for fostering the conceptual understanding of grade X students. The research used a research and development design following the 4D model of define, design, develop, and disseminate, limited in practice to the develop stage. Data were collected in May–June 2026 through content-, media-, and language-expert validation sheets and teacher and student response questionnaires, and were analysed descriptively as percentages. Twelve students took part in the small-group trial and thirty-four in the limited-group trial. Validation reached 67.69% from the content expert, 74.29% from the media expert, and 94.64% from the language expert, with an overall mean of 78.87% in the valid category. Practicality reached 95.3% from teacher responses and 90% from student responses, both highly practical. The worksheet is therefore suitable as an alternative teaching material in Biology, since it creates active and enjoyable learning, helps students recall scientific terms, and fosters conceptual understanding of animal classification.

Keywords: Student worksheet; word square; animal classification; conceptual understanding; 4D model

Abstrak:

Pembelajaran biologi tentang klasifikasi hewan di SMA Negeri 7 Bengkulu Utara masih didominasi oleh metode ceramah dan pencatatan, dengan lembar kerja yang terdiri dari latihan konvensional yang memberikan sedikit kesempatan bagi siswa untuk terlibat aktif. Observasi terhadap 32 siswa kelas X menemukan bahwa sekitar 78% siswa pasif selama pelajaran, 72% melaporkan kesulitan memahami klasifikasi hewan, dan nilai rata-rata tes harian hanya mencapai 6,8 dibandingkan dengan kriteria minimum 7,5. Studi ini bertujuan untuk menghasilkan Lembar Kerja Siswa (LKS) berupa Kotak Kata tentang klasifikasi hewan yang valid dan praktis untuk meningkatkan pemahaman konseptual siswa kelas X. Penelitian ini menggunakan desain penelitian dan pengembangan yang mengikuti model 4D yaitu mendefinisikan, merancang, mengembangkan, dan menyebarluaskan, yang terbatas pada tahap pengembangan. Data dikumpulkan pada Mei–Juni 2026 melalui lembar validasi ahli konten, media, dan bahasa serta kuesioner tanggapan guru dan siswa, dan dianalisis secara deskriptif sebagai persentase. Dua belas siswa berpartisipasi dalam uji coba kelompok kecil dan tiga puluh empat siswa dalam uji coba kelompok terbatas. Validasi mencapai 67,69% dari pakar konten, 74,29% dari pakar media, dan 94,64% dari pakar bahasa, dengan rata-rata keseluruhan 78,87% dalam kategori valid. Kepraktisan mencapai 95,3% dari tanggapan guru dan 90% dari tanggapan siswa, keduanya sangat praktis. Oleh karena itu, lembar kerja ini cocok sebagai bahan ajar alternatif dalam Biologi, karena menciptakan pembelajaran yang aktif dan menyenangkan, membantu siswa mengingat istilah-istilah ilmiah, dan menumbuhkan pemahaman konseptual tentang klasifikasi hewan.

Kata kunci: Lembar kerja siswa; kotak kata; klasifikasi hewan; pemahaman konseptual; model 4D

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Introduction

Conceptual understanding sits at the centre of what Biology instruction is meant to achieve. In the revised Bloom taxonomy the cognitive dimension runs from remembering through understanding, applying, analysing, and evaluating to creating (Sholihah & Astuti, 2025; Listiani & Rachmawati, 2022), so learning outcomes extend well beyond the memorisation of definitions to the capacity to reason with knowledge in real contexts. The Kurikulum Merdeka adopts the same orientation, emphasising activity-based learning, higher-order thinking, and the active involvement of learners (Kemendikbudristek BSKAP, 2022; Mulyasa, 2023). Clark and Hsu (2023) argue from programme learning outcomes in Biology that assessment and teaching should be aligned to this conceptual level rather than to recall alone, and Fadlilah and Herlanti (2022) found in an analysis of secondary Biology teaching that classroom process standards frequently fall short of that ambition.

The problem is visible in concrete form at SMA Negeri 7 Bengkulu Utara. Interviews with the Biology teacher and observation of 32 grade X students in the 2024/2025 academic year found that around 78% of students remained passive during lessons and 72% reported difficulty understanding animal classification, attributing this to instruction that was too theoretical and offered little exploratory activity. The mean daily test score reached only 6.8, below the school's minimum criterion of 7.5. Animal classification is a demanding topic in this respect because it requires students to hold a large vocabulary of scientific terms — vertebrata, invertebrata, karnivora, herbivora — and to use those terms to group organisms by shared and differing characteristics, which is precisely the work that rote presentation does not support.

Student worksheets are the natural vehicle for a response, since they structure what students actually do during a lesson. Their effectiveness, however, depends on the activity they carry. Sapitri et al. (2022) and Yaqutunnafis et al. (2022) demonstrated that worksheets built on problem-solving and guided inquiry raised critical thinking and learning outcomes, in contrast to conventional worksheets oriented towards completing exercises. Word Square offers one such activity: students search a grid of letters for terms that answer questions about the material, which converts vocabulary learning into a puzzle requiring careful reading and discrimination between similar terms. Aji (2022) reported increased interest in science through the strategy, and Jenny and Anisia (2025) developed a comparable crossword-based worksheet for grade X Biology.

The empirical base for Word Square in science teaching has grown considerably. Awa et al. (2025), Rahman et al. (2021), and Arlita et al. (2023) found gains in learning outcomes and critical thinking when the technique was embedded in worksheets supporting cooperative and discovery learning models; Risma et al. (2022) reported effects on Biology learning outcomes specifically; and Magfirah (2025), Nurliza et al. (2024), and Amran et al. (2023) documented improvements in outcomes and motivation at primary level. Sartika (2022), Chairanie (2022), and Suswandi (2022) applied the technique to classification material itself, combining it with observation methods. The theoretical warrant comes from dual coding, which holds that pairing verbal and visual representations strengthens retention (Wooten & Cuevas, 2024; Mir et al., 2023) — the Word Square grid presents terms in a spatial, visual form alongside their verbal definitions.

What is missing from this literature is the treatment of Word Square as the organising activity of a complete, structured printed worksheet designed specifically to foster conceptual understanding of animal classification. In the studies cited above the technique typically functions as a supplement within an existing instructional model rather than as the backbone of a purpose-built teaching material, and no such worksheet was available to the teacher at SMA Negeri 7 Bengkulu Utara. This study addresses that gap. Two questions guide the research: how valid is the developed worksheet according to content, media, and language experts, and how practical is it according to teacher and student responses?

Method

Research design

This study used a research and development design aimed at producing a Student Worksheet (LKS) based on Word Square for the topic of animal classification, intended to foster the conceptual understanding of grade X students. The development procedure followed the 4D model of *define, design, develop, and disseminate* (Thiagarajan et al., 1974), a framework whose systematic structure has been shown to support the orderly development of teaching materials from needs analysis through to final product (Permatasari & Nasruddin, 2025; Sihombing, 2024). The *disseminate* stage was not carried out because of constraints of time, cost, and distribution reach, so development was limited to the first three stages.

Setting and participants

The research was conducted at SMA Negeri 7 Bengkulu Utara, Bengkulu Province, in May–June 2026, with grade X students of the 2025/2026

academic year. Two groups of students took part: twelve students in the small-group trial, selected purposively to represent high, moderate, and low academic attainment; and thirty-four students from one randomly determined class in the limited-group trial. Three expert validators — a Biology content expert, a learning media expert, and a language expert, all lecturers at Universitas Muhammadiyah Bengkulu — assessed the worksheet, and two Biology teachers acted as practitioner respondents for the practicality test.

Instruments

Expert validation sheets assessed three domains: content and purpose validity, covering the fit between material and learning outcomes, the accuracy of scientific concepts, and the relevance of activities; construct validity, covering the clarity of instructions, the systematics of presentation, visual design, and the comprehensibility of the Word Square format; and language validity, covering readability, the accuracy of scientific terms, and suitability to learner development. Content and media instruments used a five-point Likert scale and the language instrument a four-point scale. Teacher and student response questionnaires measured practicality across student interest in the worksheet, material and science literacy, and language and presentation. Observation sheets and interview guides recorded student engagement and difficulties during the trials.

Development procedure

At the *define* stage, front-end analysis through classroom observation, teacher interview, and review of lesson plans established the gap between prevailing practice and the active learning expected under the Kurikulum Merdeka; learner analysis identified difficulty in recalling and distinguishing scientific terms; task and concept analysis mapped the essential concepts of animal classification against the curriculum learning outcomes; and instructional objectives were specified accordingly (Sa'diyah & Anantyarta, 2024). At the *design* stage, the worksheet format, content structure, Word Square design, storyboard, competency indicators, and evaluation design were prepared, following instructional design principles that require alignment between objectives, material, strategy, and assessment (Rakhmayanti, 2025; Sukmawati et al., 2025), with cognitive targets set at the remembering, understanding, applying, and analysing levels (Ratu et al., 2026). Content was drafted in Microsoft Word 2019 and the visual design developed in Canva. At the *develop* stage, the prototype was validated by the three experts, revised, trialled with twelve students, revised again, and then trialled with thirty-four students.

Data analysis

Qualitative data comprising validator comments and user responses were grouped by assessment aspect, examined for strengths and weaknesses, and used to determine what required revision before the next trial. Quantitative data were converted into percentages by dividing the score obtained by the maximum possible score and multiplying by 100. Validity percentages were interpreted following Riduwan (2013) as 85–100% (highly valid, usable without revision), 70–84% (valid, minor revision), 55–69% (moderately valid, revision needed), 40–54% (less valid, extensive revision), and 0–39% (invalid). Practicality percentages used the equivalent bands from highly practical to impractical.

Results and Discussion

The developed worksheet

The worksheet is a printed booklet organised into ten parts. The cover carries the title, the topic, the school identity, and space for the student's name and class, illustrated with the animals treated in the material. A preface states the purpose of the worksheet, and usage instructions set out the sequence of work. A section on learning outcomes and objectives specifies what students should achieve: identifying animal characteristics, grouping animals by classification, and understanding the scientific terms involved. An introduction to the material covers the definition and purpose of classification, the bases of animal grouping, and the division into vertebrates and invertebrates. A contextual story presents observations of animals in the surrounding environment to build initial understanding. The main Word Square activity requires students to locate answers within a letter grid in response to questions on the material. Comprehension questions, a reflection page, and a bibliography complete the structure.



Figure 1. The developed Word Square worksheet: cover, contextual story, main activity, and reflection

Validity

Expert validation results are summarised in Table 1.

Table 1. Expert validation results

Validator	Score	Max	%
Content expert	44	65	67.69
Media expert	52	70	74.29
Language expert	53	56	94.64
Overall mean	—	—	78.87

The three validators produced markedly different judgements, and the divergence is informative. The language expert awarded 94.64%, in the highly valid category, with full marks on straightforwardness, communicativeness, dialogic and interactive quality, and suitability to learner development, and 87.5% on conformity to Indonesian language conventions. The media expert awarded 74.29%, in the valid category, with high ratings for text legibility, clarity of presentation, colour and image clarity, and layout, but lower ratings for the attractiveness of text presentation, the fit between images and the Word Square, the contextual relevance of images, and design creativity; the validator recommended adding the invertebrate and vertebrate classification to the cover.

The content expert awarded 67.69%, in the moderately valid category and the lowest of the three. Thirteen of fourteen items were scored, the item on material accuracy having been left blank by the validator. The lowest single rating, 40% for the fit between images and material, together with written comments that the typography required correction, that consistency between the LKS and LKPD formats should be maintained, and that the level of conceptual understanding in the indicators and questions should be raised, locates the weakness precisely: the material and its illustration, rather than the language or the general layout. This is a substantive finding rather than an inconvenience. A worksheet whose language is excellent and whose design is adequate can still fall short if the images do not carry the conceptual load the material requires, and in a topic built on distinguishing morphological characteristics, image accuracy is not decorative.

The overall mean of 78.87% places the worksheet in the valid category, usable with minor revision. Revisions were carried out accordingly: the material on vertebrate and invertebrate classification was expanded, scientific terms corrected, and more varied examples added; the cover design, page layout, image size, typeface, and colour combination were reworked; and spelling, punctuation, and sentence complexity were adjusted to grade X level. The contextual story and the images were replaced so that the animals appearing in the illustrations matched those named in the story, a bibliography was added, one task removed, and a reflection page inserted.

Practicality

Practicality in this study was examined from two complementary viewpoints. The teachers evaluated whether the worksheet could be integrated into Biology instruction with manageable demands on explanation, organisation,

and classroom use, whereas the students evaluated the worksheet as its direct users. This distinction is important because a teaching material may be technically well designed but still difficult for students to engage with, or conversely attractive to students while creating additional instructional burdens for the teacher. The teacher and student responses are presented in Tables 2 and 3.

Table 2. Teacher responses to the practicality of the worksheet (n = 2)

Assessed aspect	%	Category
Student interest in the worksheet	96.7	Highly practical
Material and science literacy	95.0	Highly practical
Language and presentation	93.3	Highly practical
Overall mean	95.3	Highly practical

The teacher responses yielded an overall score of 95.3%, placing the Word Square worksheet in the highly practical category. More importantly, the scores across the three dimensions were closely clustered, ranging only from 93.3% to 96.7%. This pattern indicates that the teachers did not perceive practicality as resting on a single attractive feature; rather, they regarded the worksheet as workable across motivational, substantive, and communicative dimensions.

The highest rating, 96.7%, was recorded for student interest in the worksheet. This result is consistent with the intended character of the product. Instead of presenting animal classification only through explanatory text and conventional questions, the worksheet requires students to search for scientific terms within a Word Square grid and connect those terms with conceptual clues. The activity therefore introduces an element of challenge into a topic that students had previously experienced largely through lecture and note-taking. From the teachers' perspective, this format appeared sufficiently engaging to sustain student involvement without abandoning the academic content of the lesson.

Material and science literacy received a similarly strong score of 95.0%. This finding suggests that teachers considered the worksheet not merely entertaining, but sufficiently connected to the concepts and terminology of animal classification. This distinction is central to the design of educational puzzles. A Word Square activity has instructional value only when locating a term requires students to relate the word to its scientific meaning, characteristics, or classification context. In the developed worksheet, the grid is therefore positioned as part of the learning sequence rather than as an isolated recreational exercise.

Language and presentation received 93.3%, the lowest of the three teacher ratings but still comfortably within the highly practical category. Teachers considered the instructions understandable, the material systematically arranged, and the language sufficiently communicative for grade X students. The slightly lower score relative to the other dimensions nevertheless suggests that clarity of presentation remains an area in which further refinement is possible, particularly as the worksheet contains scientific vocabulary that may be unfamiliar to learners encountering animal classification in greater conceptual depth.

The students' assessment provides a second and equally important indication of how the worksheet functioned during use.

Table 3. Student responses to the practicality of the worksheet

Assessed aspect	%	Category
Interest in the worksheet	90.0	Highly practical
Material and science literacy	90.0	Highly practical
Language	90.0	Highly practical
Overall mean	90.0	Highly practical

Student responses produced an overall practicality score of 90.0%, also within the highly practical category. Unlike the teacher responses, the student scores were identical across all three assessed aspects. The uniformity is noteworthy because it suggests a relatively balanced user experience: students did not respond positively to the visual or game-like element while simultaneously finding the language or material difficult to use. Instead, interest, content-related usability, and language were evaluated at the same high level.

This balanced response is strengthened by the classroom observations conducted during the trial. Students showed particular interest when working with the Word Square because the activity differed from the worksheets they ordinarily encountered. Searching the grid encouraged them to return to the accompanying material, interpret the clues, distinguish among scientific terms, and discuss possible answers with peers. Classroom interaction was therefore not confined to completing blanks on a worksheet; the task generated reading, searching, checking, and discussion around the concepts being studied.

The student interviews add further texture to the numerical findings. Most students described the worksheet as attractive and relatively easy to understand, while several characterised the Word Square activity as resembling an educational game.

Images and animal examples were also perceived as helping them understand the material. These responses are consistent with previous findings that Word Square-based activities can increase interest, motivation, and classroom participation because they combine curricular content with an element of problem solving and visual search (Aji, 2022; Amran et al., 2023; Devi et al., 2022). In this study, however, the value of the Word Square lies not simply in making the lesson more enjoyable, but in creating repeated encounters with the scientific vocabulary required for animal classification.

At the same time, the trial did reveal concrete points at which usability could be improved. Some students experienced difficulty locating unfamiliar scientific terms in the grid, and several required additional explanation for particular instructions. Their suggestions to enlarge the letters and provide a worked example before the main activity were therefore pedagogically significant rather than merely cosmetic. Both suggestions were implemented in the revised product. These responses show that practicality was treated as an iterative design criterion: difficulties encountered by learners became evidence for improving the accessibility of the activity before subsequent use.

A particularly informative finding emerges when the practicality results are read alongside the expert-validation results. The worksheet obtained an overall validity score of 78.87%, while teacher and student practicality reached 95.3% and 90.0%, respectively. The difference should not be interpreted as a contradiction because the two assessments address different dimensions of product quality. Expert validation asks whether the content, design, and language satisfy professional and disciplinary criteria; practicality asks whether the product can be understood, operated, and incorporated into an actual learning situation.

This distinction becomes clearer when the content-expert score of 67.69% is considered. The validator identified weaknesses related to conceptual depth, alignment between images and material, and the cognitive level of several indicators and questions. These concerns remain substantive even though teachers and students found the worksheet easy and engaging to use. High practicality therefore does not erase the need for content revision. Rather, the combination of results describes the developmental status of the product more precisely: the worksheet possesses strong classroom usability, while its conceptual architecture still requires strengthening if it is to support more demanding levels of conceptual understanding.

Such a pattern is especially relevant to Word Square-based materials. The format naturally supports recognition, recall, discrimination among terms, and the reinforcement of vocabulary. These processes are useful in animal classification, where students must distinguish numerous categories and scientific terms. Yet conceptual understanding cannot be reduced to locating correct words in a grid. To move beyond terminology toward deeper understanding, the Word Square should be connected with questions that require students to explain classification criteria, compare animal groups, justify their decisions, and interpret observable characteristics. The content validator's recommendation to raise the cognitive level of the indicators and questions therefore complements, rather than conflicts with, the high practicality ratings.

The practical value of the worksheet can also be understood through the interaction between verbal and visual information. Dual coding theory proposes that information represented through verbal and visual channels can strengthen retention when the two representations are meaningfully connected (Mir et al., 2023; Wooten & Cuevas, 2024). Within the present worksheet, conceptual clues provide the verbal representation, while the spatial arrangement of terms in the Word Square and the accompanying animal illustrations provide visual cues. Students must coordinate these representations when identifying the appropriate term. Their reported ability to remember key concepts and their active engagement during the task are compatible with this theoretical explanation, although the present study did not experimentally measure the causal contribution of dual coding.

Taken together, the responses indicate that the worksheet achieved a high degree of classroom operability. Teachers viewed it as manageable, relevant, and communicatively appropriate, while students experienced it as accessible and engaging. The observational findings further show that this practicality translated into active interaction with the task rather than passive worksheet completion. Nevertheless, practicality should be interpreted here as evidence of usability, not as proof of instructional effectiveness. Because the study did not employ a pre-test-post-test comparison or control group, it cannot establish that the worksheet caused an increase in conceptual understanding. What the evidence does demonstrate is that the developed Word Square worksheet can be implemented smoothly in the classroom and can provide an engaging structure through which students encounter, identify, discuss, and organise concepts related to animal classification.

Thus, the most meaningful outcome of the practicality test is not simply that both respondent groups produced percentages above 90%. Its significance lies in the convergence of three forms of evidence: teachers considered the material workable for instruction, students considered it accessible for learning, and classroom observation showed that the Word Square activity generated active engagement with scientific terms and classification concepts. This convergence provides a strong practical foundation for further refinement of the worksheet, particularly in strengthening conceptual depth and extending the activity toward higher levels of cognitive processing.

Trial observations

Observation during the small-group trial showed most students responding positively to the worksheet. Students appeared interested when working on the Word Square activity because it differed from the worksheets ordinarily used, and most worked to find answers matching the given clues, searching for terms related to animal classification within the grid. The activity prompted students to read the material more closely, to think about the concepts, and to discuss with group members. Interaction between students and teacher was active, marked by frequent questions and responses. Some students, however, had difficulty locating answers in the grid, particularly for scientific terms unfamiliar to them, and required additional guidance to understand instructions in certain sections.

Interviews confirmed and extended these observations. Most students described the worksheet as attractive and easy to understand, and reported feeling more motivated because the Word Square activity resembled an educational game. They valued the images and animal examples as aids to understanding, and said the activity helped them remember key concepts and felt more challenging than reading a book or listening to explanation. Several suggested enlarging the letters in the Word Square grid and providing a worked example before the main activity. Both suggestions were implemented, and both concern accessibility of the activity rather than its substance — a useful signal that students were engaging with the task closely enough to notice where it obstructed them.

Discussion

The results indicate that the Word Square activity operates on the lower and middle levels of the cognitive dimension rather than across its full range. Students remembered scientific terms, understood the characteristics distinguishing animal groups, and applied those characteristics to

group organisms. What the activity does not by itself demand is evaluation or creation, and the content validator's recommendation that the level of conceptual understanding in the indicators and questions be raised addresses precisely this ceiling. Anjani (2026) reached a comparable conclusion in developing a HOTS-oriented electronic worksheet, finding that activities must be designed deliberately for analysis, evaluation, and creation if higher-order thinking is the goal.

The dual coding account offers the most economical explanation for the effects observed. Wooten and Cuevas (2024) and Mir et al. (2023) show that pairing verbal and visual representation strengthens the retention of vocabulary and scientific concepts. In the Word Square activity a term exists simultaneously as a verbal definition in the clue and as a spatial pattern in the grid, and locating it requires the student to hold both representations at once. This is consistent with the students' own reports that the activity helped them remember concepts, and with the finding that engagement and discussion increased during the task.

The findings align with the broader literature on Word Square in science teaching. Risma et al. (2022), Magfirah (2025), and Nurliza et al. (2024) reported gains in learning outcomes, Amran et al. (2023) and Tussa'diah et al. (2025) in motivation and classroom activity, and Sartika (2022), Chairanie (2022), and Suswandi (2022) specifically on classification material combined with observation methods. The present study differs from these in treating Word Square as the organising activity of a purpose-built printed worksheet developed through a full 4D procedure, rather than as a technique inserted into an existing instructional model.

Several limitations qualify the conclusions. The *disseminate* stage was not carried out, so the worksheet has not been tested beyond a single school. Content validity at 67.69% remains the weakest result and indicates that the material requires further revision before wider use; the item on material accuracy was moreover left unscored by the validator and should be reassessed. The study establishes validity and practicality but not effectiveness: no control group or pre-test-post-test comparison was used, so the extent to which the worksheet improves measured conceptual understanding remains an open question.

Conclusion

The Word Square Student Worksheet on animal classification developed in this study is declared valid, with content-expert validation at 67.69%, media-expert validation at 74.29%, and language-expert validation at 94.64%, giving an overall mean

of 78.87% in the valid category. It is declared highly practical, with teacher responses at 95.3% and student responses at 90%. The worksheet is therefore suitable as an alternative teaching material for Biology instruction on animal classification at grade X, since it is easy to use, attractively presented, written in accessible language, and able to help students recall scientific terms and understand the characteristics of animal groups. Its principal contribution is to place Word Square at the centre of a structured printed worksheet rather than using it as an adjunct to another instructional model. Future research should test effectiveness experimentally through a pre-test-post-test design, revise the material and its illustration in line with the content validator's recommendations, raise the cognitive demand of the indicators and questions towards analysis and evaluation, and carry out the dissemination stage across a wider group of schools.

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Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Eriyanto: conceptualization, methodology, investigation, data curation, writing—original draft. Apriza Fitriani: supervision, validation, writing—review and editing. Mariana Ade Cahaya: supervision, methodology, writing—review and editing.

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