

Developing a Contextualized Assessment in Physics Learning Book for Physics Education Students: AaL, AfL, and AoL Frameworks

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Abstrak/Abstrack

Physics education graduates are expected to master assessment competence as a key component of their professional skills. Effective assessment is crucial for ensuring student understanding and successful physics learning. This study aimed to develop a digital book, "Contextualizing Assessment in Physics Learning: AaL, AfL, AoL," suitable for use in Physics Learning Assessment courses. The digital book was developed using the 4D model (Define, Design, Develop, Disseminate). Validation sheets, readability questionnaires, and student worksheets for creating physics problems were used as instruments. The material, presentation, and Android application aspects received valid scores, with averages above 3.80. Readability tests yielded scores > 90, indicating excellent suitability. Research results demonstrate that students' competence in creating physics problems improved after using this digital book. This improvement suggests that "Contextualizing Assessment in Physics Learning: AaL, AfL, AoL" has the potential to be an effective resource for enhancing physics teacher assessment competence through structured interventions and direct supervision in lectures.

Keywords: Assessment for Learning (AfL) · Assessment as Learning (AaL) · Assessment of Learning (AoL) · Digital book development · Pre-service physics teacher

INTRODUCTION

The ability of professional and employable graduates is a primary concern and quality assurance for universities (Thompson & Houston, 2024). One of the important professional skills for a graduate of education, especially prospective teachers, is implementing assessment in learning (Sandal, 2023). Effective assessment practices involve a variety of approaches, including assessment as learning (AaL), assessment for learning (AfL), and assessment of learning (AoL) (Berry, 2008).

AfL, with its emphasis on activity design, evaluation, and feedback that enhance learning, plays a crucial role in achieving learning objectives (Memarian & Doleck, 2024). The proper use of AfL can support the teaching and learning process, identify the achievement of learning objectives, and guide the design of effective instruction (Moura dkk., 2021). AaL, for example, integrates self-assessment and peer-assessment as an integral part of the learning process, which contributes to students' personal and cognitive development (Yin dkk., 2022). Meanwhile, AoL, as part of summative assessment, provides motivation that drives student

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learning (Fischer dkk., 2024). The harmonious integration of teaching, learning, and assessment is essential to improve students' achievement standards as prospective teachers (Berry, 2008)

Assessment mastery is a fundamental pedagogical competence for prospective physics teachers, as it directly influences the effectiveness of instructional design and the achievement of educational goals (Mariyani et al., 2023). At the University of Jember, this competency is developed through the Physics Learning Assessment course. To identify students' actual needs, a preliminary study was conducted by distributing a needs assessment questionnaire to 48 physics education students specifically those in the 3rd and 7th semesters, aged 18 to 21 years who were enrolled in the Assessment, English, and STEM courses. The results showed that 54.2% of respondents reported needing appropriate teaching materials, and they experienced difficulties in mastering and integrating the three types of assessment: Assessment as Learning (AaL), Assessment for Learning (AfL), and Assessment of Learning (AoL).

Students expressed confusion in distinguishing the purpose and application of each assessment type, particularly within the context of physics instruction. These findings highlight a significant instructional gap and emphasize the necessity of developing a structured, relevant, and comprehensive learning resource. In response to this need, this study aims to develop a digital textbook titled "Contextualization of Assessment in Physics Learning: AaL, AfL, AoL", which explicitly integrates the three assessment approaches into selected physics content, particularly static and dynamic fluids. This e-book is expected to bridge the gap between student needs, graduate profile expectations, and the lack of context-specific assessment learning materials, ultimately enhancing the assessment competence of pre-service physics teachers.

METHOD

This research and development (R&D) used the 4D model (Lawhon, 1976). Development stage, validity test from experts, analyzed using equation (1) (Baihaqi dkk., 2022).

$$\bar{x} = \frac{\sum x}{n} \quad (1)$$

where \bar{x} is average value, $\sum x$ is total score of the assessment answers, and n is number of valudators. The interpretation of every value is shown in Table 1.

Table 1. Validty Criteria

Range	Validity Criteria
3.28 – 4.00	Valid
2.52 – 3.27	Valid Enough
1.76 – 2.51	Less Valid
1.00 – 1.75	Invalid

The readability score of the e-book was determined based on the criteria presented in Table 2 (Supahar dkk., 2024).

Table 2. Criteria for Readability Assessment of E-book Feasibility

Responden Score	Score	Criteria
$X \geq X_1 + 1,0SB_i$	$X \geq 73.33$	Very worthy
$X_1 < X \leq X_1 + 1,0SB_i$	$60 < X \leq 73.33$	Worthy
$X_1 - 1,0SB_i < X \leq X_1$	$46.67 < X \leq 60$	Not worthy
$X < X_1 - 1,0SB_i$	$X < 46.67$	Very not worthy

where x is average score where x is formulated by $\left(\frac{x_i}{n}\right)$ in which x_i is the number of scores from i to $,n$ and n is the number of panelists/validators; X as ideal mean where X is formulated by $\left(\frac{\text{ideal max score} + \text{ideal min score}}{2}\right)$, SB_i is ideal standard deviation $\left(\frac{1}{6}\right)(\text{ideal max score} - \text{ideal min score})$.

Then, the research flow is presented in Figure 1 below.

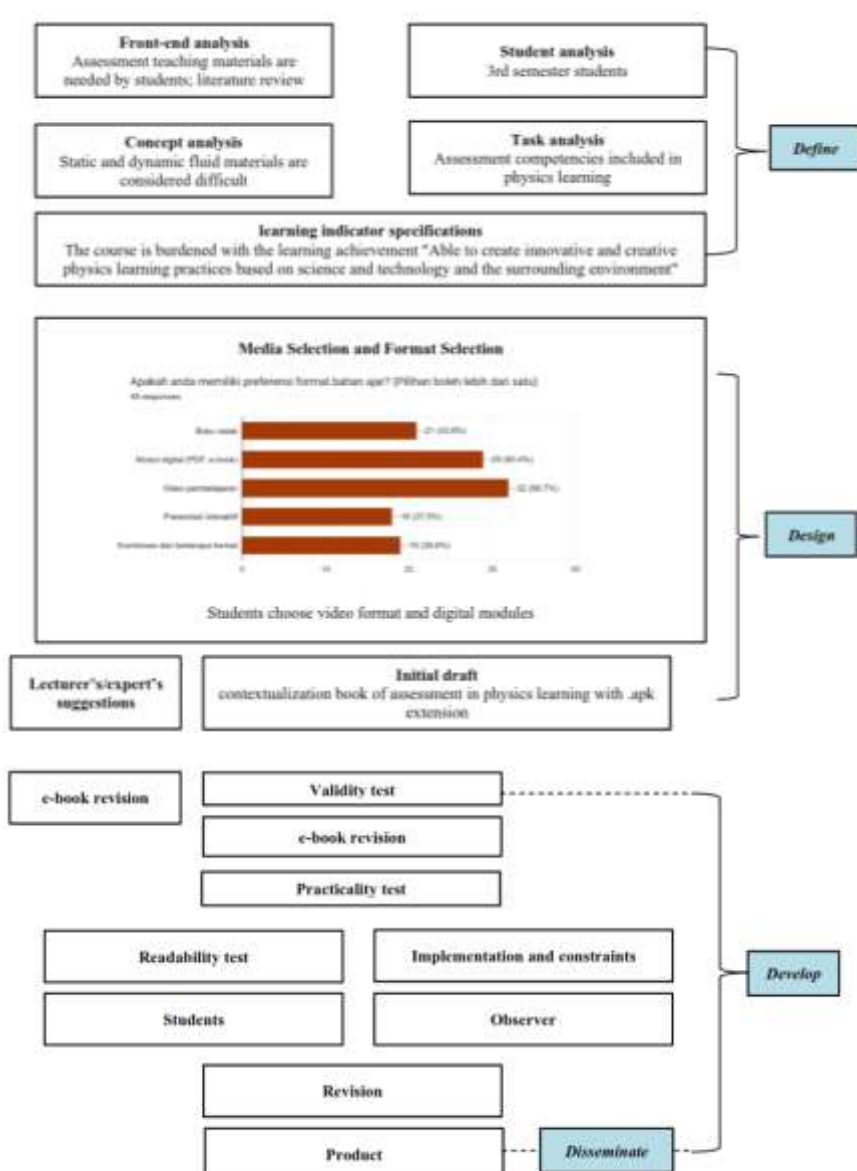


Figure 1. Research and Development Flow using 4D Model

RESULTS AND DISCUSSION

Define Stage

In the Define Stage, research was conducted on the needs of teaching materials for 48 physics education students which were distributed through a Google Form questionnaire, with the results showed in Figure 2.

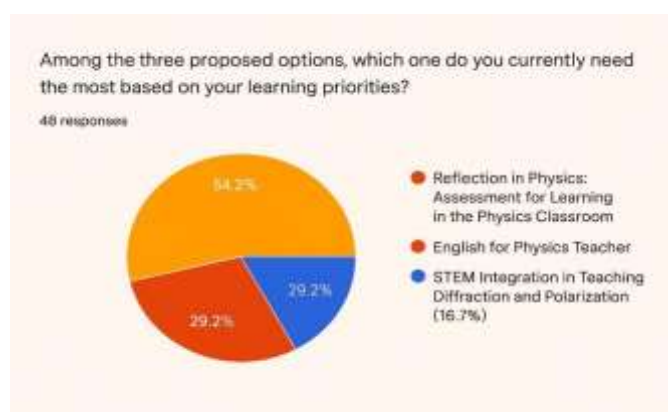


Figure 2. Results of the Physics Education Students' Teaching Material Needs Questionnaire

At the design stage, the selection of media and formats for teaching materials takes into account student preferences obtained from the questionnaires that have been distributed. Students preferred e-book format. The development of the digital book "Contextualization of Assessment in Physics Learning: AaL, AfL, AoL" can be referred to as an e-module or e-book. The e-book that has been developed is more interactive, used for online and offline learning, and easy to carry, according to research results (Sari dkk., 2022). Physics Education E-books and Physics E-books have excellent opportunities to be developed (Dawana dkk., 2022).

Design Stage

Students look active and enthusiastic when using Android as a learning medium (Rahmayani, 2024). With these considerations, this e-book was developed in the .apk extension for use on Android. Books can be installed easily, and videos can also be played smoothly. Before it was in the form of Android, there was an HTML version that could be accessed via a computer. Selected layouts from the design stage of the e-book (see APPENDIX 1).

Questions in the form of tests, because students' difficulties in solving physics problems can be known after students are given an evaluation in the form of a test (Nurhaniah dkk., 2022). The material used as an example in this book is Static Fluids and Dynamic Fluids. The causes of students' difficulties in solving dynamic fluid problems are not understanding the sentences in the questions, not working on the questions themselves, and relying on friends' answers (Ahmad dkk., 2024; Yusuf dkk., 2022). Therefore, in developing Dynamic Fluid questions as an application of AoL, teachers need to have the competence to compile good questions so as not to make it difficult for students to understand. The fluid material here is related to everyday life. This is important to be compiled in a book so that students find

concepts by paying attention to phenomena that occur in the surrounding environment and are then manifested in mathematical manifestations (Widarti dkk., 2023).

Develop Stage

To collect response evidence and feedback, three expert validators were involved in the validation process by completing structured assessment sheets, which included Likert-scale ratings and qualitative comment sections. Additionally, the revised e-book was distributed to 50 students of the Physics Education program who were currently taking the Physics Assessment course. These students were asked to evaluate the e-book through a Google Form questionnaire using a 1–5 scale, assessing aspects such as content readability, layout, navigation, and overall engagement. The feedback obtained was then analyzed and used to refine the e-book before broader dissemination. The validation results from experts are shown in Table 3.

Table 3. Average Results of E-Book Validation

Component	V1	V2	V3	Average	Interpretation
Teaching Materials	4.00	3.83	3.83	3.86	Valid
Presentation	3.60	3.90	3.90	3.80	Valid
Assessment Book as Android Application	4.00	3.83	4.00	3.94	Valid

The average value of the e-book as an Android application is 3.94 which is classified as very feasible. E-books that are developed usually contain digital information such as images, text, to improve student competence (Damayanti & Yohandri, 2022) therefore the presentation aspect must be assessed for its feasibility. The presentation aspect gets an average of 3.80 and is included in the valid category. Several aspects of presentation that are included in the assessment components by experts are language, cover, color, font size, and the selection of language that is easy to understand by the level of students do need to be considered in the same way as what was done (Mulhayatiah dkk., 2022). Interactive computer-based learning media can support the presentation of materials in the era of globalization, meaning that the media utilizes technology in the field of education (Fatikhah & Anggaryani, 2021).

Creating a comprehensive module requires a learning base and integration with other media by the following technological developments (Khair dkk., 2021). Therefore, in this e-book there are learning videos that can be played by students whenever and wherever they are. It is important to include videos in an e-book to guide readers to understand the material (Ramli dkk., 2021).

AfL can improve student achievement even though teachers find AfL difficult to implement coherently because it requires complex professional competencies (de Vries dkk., 2022). The application of AfL that is exemplified for students as prospective teachers is asking their students to what extent they understand the material. AfL practices apply activity design, evaluation processes, and feedback, which emphasize communication to improve student learning (Memarian & Doleck, 2024). By actively asking students, teachers can obtain evidence of student progress. The application of AfL is to collect the psychological basis of learning to design appropriate instruction and learning (Wolterinck dkk., 2024).

Peer assessment is used as one of the assessment as learning practices that is oriented towards formative assessment (Yin dkk., 2022). In this book, AaL is exemplified by the class

is divided into 3 groups (low, mid, high). The low group had a chance to ask to high and mid groups. They also did a peer assessment of the other group. The way of learning should be richer and more authentic with the right assessment and learning design (Crawford dkk., 2023).

The development of this e-book facilitates physics education students who have gone through the Covid-19 pandemic, where research states that although there is a major disruption to student learning, students have good personal resource factors, adaptability, and motivation because of the pandemic (Martin dkk., 2023). Through students' self- efficacy and willingness to learn independently, it is expected that this e-book will help them improve their competence in making/compiling physics questions. The difference in the competence of compiling questions of physics education students before and after using the e-book is shown in Table 4.

Table 4. Average Results of E-Book Validation

Students	Score "First Assignment: Making Physics Question Cards"	Score of "Second Assignment: Making Physics Question Cards"	N-Gain
A01	47.50	67.86	0.39
A02	85.00	92.86	0.52
A03	72.50	75.00	0.09
A04	85.00	96.43	0.76
A05	72.50	85.71	0.48
A06	65.00	78.57	0.39
A07	87.50	89.29	0.14
A08	77.50	82.14	0.21
A09	90.00	100.00	1.00
A10	77.50	85.71	0.36
A11	50.00	60.00	0.20
A12	56.50	64.29	0.18
A13	90.00	96.43	0.64
A14	80.00	85.71	0.29
A15	82.50	85.71	0.18
A16	65.00	78.57	0.39
A17	70.00	85.71	0.52
A18	90.00	96.43	0.64
A19	92.50	96.43	0.52
A20	92.50	100.00	1.00
A21	70.00	85.71	0.52
A22	87.50	100.00	1.00
A23	95.00	100.00	1.00
A24	87.50	92.86	0.43
A25	90.00	96.83	0.68
A26	72.50	75.00	0.09
A27	82.50	85.71	0.18
A28	72.50	85.71	0.48
A29	85.00	96.43	0.76
A30	62.50	71.43	0.24
A31	82.50	92.86	0.59
A32	82.50	100.00	1.00

Table 4 displays the comparative scores of 32 students before and after using the e-book. All students demonstrated improvement, with N-Gain values ranging from 0.09 (low) to 1.00 (high). A total of 10 students (31.25%) achieved high gains ($N\text{-Gain} \geq 0.7$), 15 students (46.9%) showed moderate gains ($0.3 \leq N\text{-Gain} < 0.7$), and 7 students (21.9%) were in the low gain category ($N\text{-Gain} < 0.3$).

These results indicate a generally positive impact of the e-book, especially in improving students' competence in designing physics questions. The improvement is encouraging, even though the e-book was used without direct instructional support and was accessed outside scheduled class hours. The lack of scaffolding may explain why some students achieved only low to moderate gains. Nonetheless, the data supports the potential of the developed e-book as a formative learning tool in the Physics Learning Assessment course. The observed outcomes were suboptimal due to the absence of direct guidance during e-book utilization. Students engaged with the material outside of scheduled class time, potentially impacting the depth of their engagement. Consequently, it is plausible that students did not thoroughly study the content, instead opting for a cursory review. Meanwhile, this e-book is very interesting and gets a readability score based on the scores from students as shown in Table 5.

Table 5. Student Response Analysis Results

Assessment	Component	Average	Value	Category
Readability of content	Language and Style	4.67	93.40	Very Worth
	Structure and Organization	4.56	91.20	Very Worth
	Information completeness	4.62	92.30	Very Worth
Design and Operation	Layout	4.51	90.14	Very Worth
	Navigation	4.62	92.40	Very Worth
	Operational	4.47	89.40	Very Worth
Interest	Interest.00	4.71	94.20	Very Worth

DISSEMINATE STAGE

The wide-scale implementation of this e-book is scheduled for the odd semester of the 2025–2026 academic year, considering that the development process was completed at the end of the 2024–2025 odd semester. This timeline aligns with the curriculum structure, in which the Physics Learning Assessment course is only offered during odd semesters. Nevertheless, the contextualized assessment e-book (AaL, AfL, AoL) is already available in two digital formats: an HTML version for PC access and an Android-compatible .apk version, ensuring flexible accessibility for students.

As part of the long-term dissemination strategy, the printed version of the e-book is currently under preparation to obtain an ISBN. This printed version is expected to enhance its accessibility and facilitate broader adoption, particularly among physics education students from other universities. The availability of both digital and printed formats is intended to support sustainable integration of assessment literacy into physics teacher education programs.

Overall, the results obtained through each stage of the 4D development model indicate that the integration of AaL, AfL, and AoL in a contextualized digital book has the potential to significantly enhance students' assessment literacy. The moderate-to-high N-gain scores observed in most students suggest that this instructional resource can effectively support learning even when used independently, outside regular lecture sessions. This aligns with the findings of (de Vries dkk., 2022) and (Yin dkk., 2022), who emphasized the importance of assessment integration and peer-assessment in teacher preparation.

In particular, the positive reception of the book's readability, structure, and interactivity, as shown in the student response analysis, demonstrates that students value materials that are visually accessible, well-organized, and responsive to their real classroom needs. The results also confirm the relevance of combining assessment theory with familiar physics content such

as fluids, making it easier for students to understand abstract concepts through contextual examples (Widarti dkk., 2023).

Furthermore, this study contributes practically by offering a model for assessment-oriented instructional design using digital platforms (Android/.apk and HTML). This is especially timely in post-pandemic contexts, where independent learning and digital media literacy have become essential (Azila-Gbettor dkk., 2023). Future implementations may further enhance the impact of this e-book if accompanied by structured discussions, peer collaboration, and formative feedback cycles guided by instructors.

Thus, beyond content delivery, this e-book also functions as a training tool for professional habits, encouraging reflective practice, peer dialogue, and self-monitoring, and key attributes of competent 21st-century educators (Crawford dkk., 2023; Fischer dkk., 2024).

CONCLUSION

The digital book "Contextualization of Assessment in Physics Learning: AaL, AfL, and AoL" has been successfully developed and validated in terms of teaching materials, presentation, and feasibility as an Android application and HTML version. The application of the principles of AaL, AfL, and AoL in this book has been proven to have a positive impact on improving student performance in compiling physics questions and answer keys. This finding indicates that independent learning using a contextual assessment book can improve the ability to design relevant and comprehensive physics questions. Further research with a more controlled design, such as the use of control groups and structured interventions, is needed to confirm these findings and quantify the impact of the book more accurately. In addition, further development of the book content, especially in integrating more diverse assessment strategies, can be done to improve its effectiveness.

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APPENDIX

Layout of html version e-book	E-book menu
	
Introduction, 'types of assessment' section	Practice of <i>assessment for learning</i> in the data collection step

Kemudian memperbaiki proses belajar mengajar tersebut dan menentukan kelulusan peserta didik. Fungsi asesmen bagi peserta didik untuk mengetahui kemampuan dan hasil belajarnya, serta memperbaiki cara belajar. Selain itu, dapat meningkatkan motivasi belajar bagi peserta didik. Berdasarkan uraian tersebut menurut Harisati (2011:10–11) fungsi asesmen bagi pendidik sebagai berikut. 1) Memberikan landasan untuk menilai hasil usaha yang diperoleh peserta didik. 2) Memberikan informasi yang sangat berguna untuk mengetahui kemampuan masing-masing peserta didik dalam tugas kelompok. 3) Memberikan bahan yang dapat digunakan sebagai pertimbangan dalam menentukan kelulusan dari peserta didik. 4) Memberikan pedoman untuk memberikan solusi bagi peserta didik yang mengalami kesulitan belajar.

3. Jenis-jenis Asesmen

Asesmen dibagi menjadi 2 jenis, yaitu asesmen sumatif dan formatif. Asesmen formatif biasanya terintegrasi dengan proses pembelajaran yang perencanaannya dibuat menyatu dengan perencanaan pembelajaran. Hal-hal yang dinilai dalam asesmen formatif ini ialah sikap, pengetahuan, keterampilan, motivasi belajar. Kerjasama dalam proses pembelajaran, yang melibatkan berbagai ranah kemajuan penguasaan siswa. Itulah mengapa asesmen formatif membutuhkan strategi/metode pembelajaran dan teknik penilaian yang tepat.

MENU

Practice of *assessment for learning* in the closing step

Syntax discovery learning	Kelompok High	Kelompok Mid	Kelompok Low
[problem statement dan data collection]	Siswa dari kelompok ini diminta untuk memberikan tugas angin diatas kertas dan mencatat apa yang terjadi (kertas akan mengembang/te tarik ke bawah)	Salah seorang siswa diminta untuk memegang kertas di hadapan semprotan besar dan siswa lain untuk meutup semprotan yang besar (air pada gelas akan tessemprot ke kertas)	Siswa diminta untuk mencari informasi tentang perbedaan kecepatan dan tekanan udara diatas dan di bawah sayap, dan penerapan hukum bernoulli pada obat semprot nyamuk
	Perwakilan kelompok diminta untuk memberikan tugas angin dibawah kertas dan mencatat apa yang terjadi pada kertas (kertas akan mengembang/te tarik ke bawah)	Guru bertanya "apakah siswa memahami Langkah percobaan?" (assessment for learning)	Guru bertanya "apa yang menjadi kesulitan dalam memahami penerapan Bernoulli tersebut?" (assessment for learning)
	Guru bertanya "apakah siswa memahami Langkah percobaan?" (assessment for learning)		

MENU

Practice of *assessment as learning* in the data processing step

[verification]	<ul style="list-style-type: none"> Masing-masing kelompok mempresentasikan hasil percobaan di depan kelas Kelompok low diperalihkan mengajukan pertanyaan kepada kelompok yang presentasi Guru memberi konfirmasi atas jawaban siswa dalam presentasi Guru meluruskan jawaban yang kurang tepat dari siswa Guru memberi penguatan terhadap materi Hukum Bernoulli dan memberi penghargaan bila jawaban siswa tepat dengan gubahan 		
	<p>Kegiatan Penutup</p> <ul style="list-style-type: none"> Guru bersama dengan siswa merefleksikan dan menyimpulkan kegiatan pembelajaran terkait materi Hukum Bernoulli dan penerapannya dalam kehidupan sehari-hari melalui percobaan. Guru meminta siswa menuliskan pada selambar kertas: (assessment for learning) <ol style="list-style-type: none"> 1. Apa yang telah mereka pelajari hari ini. 2. Apa yang mereka pahami dari percobaan 1 dan 2 3. Apa yang belum mereka pahami dalam pembelajaran kali ini 4. Apa yang mereka harapkan untuk di review di pertemuan berikutnya 5. Saran terhadap pembelajaran <ul style="list-style-type: none"> Mengakhiri pembelajaran dengan membaca doa Memberi salam penutup 	15 menit	

MENU

Example of Question that the low froup may ask to high group

[data processing]	Siswa diminta untuk menghubungkan apa yang telah mereka peroleh dengan hukum Bernoulli	Siswa dari kelompok mid diminta untuk menjelaskan peristiwa tersebut sebagai miniaturnya obat nyamuk dan penerapan hukum Bernoulli	Siswa diminta untuk mempersiapkan pertanyaan tentang: Perbedaan kecepatan dan tekanan udara diatas dan di bawah sayap sebagai penerapan hukum bernoulli kepada kelompok high
	Siswa dari kelompok high diminta untuk membuat rubrik penilaian atas percobaan yang telah mereka lakukan (assessment as learning, lampiran 2)	Guru meminta siswa dari kelompok mid untuk membuat rubrik penilaian atas percobaan yang telah mereka lakukan (assessment as learning, lampiran 3)	Penerapan hukum bernoulli pada obat semprot nyamuk kepada kelompok mid (assessment as learning, lampiran 4)

MENU

AoL Contextualization through Questions for Last Evaluation

Lampiran 4

Kemungkinan pertanyaan yang dibuat oleh kelompok lain sebagai penerapan assessment di learning.

10. Pertanyaan saat kegiatan low speed kelompok lain.

1. Apa yang terjadi saat angin ditupkan diatas kertas?
2. Apa yang terjadi saat angin ditupkan di bawah kertas?
3. Jelaskan hasil yang kalian dapatkan dan hubungkan dengan Hukum Bernoulli!
4. Jelaskan hubungan antara kecepatan aliran fluida, tekanan, dan gaya angkat pada percobaan tersebut!
5. Jelaskan kaitan percobaan tersebut dengan gaya angkat pada sayap pesawat!
6. Dapatkah kalian menyebutkan contoh lain penerapan Hukum Bernoulli pada kehidupan sehari-hari selain percobaan dan gaya angkat pada sayap pesawat? Apa saja?

11. Pertanyaan saat kegiatan low speed kelompok lain.

1. Apa yang terjadi setelah meniupkan angin di sedotan besar?
2. Jelaskan hubungan antara kecepatan aliran fluida dan tekanan pada percobaan tersebut!
3. Jelaskan hasil yang kalian dapatkan dan hubungkan dengan Hukum Bernoulli!
4. Jelaskan kaitan percobaan tersebut dengan obat semprot nyamuk!

MENU

**KARTU SOAL NOMOR 2
(UBAHAN)**

Mata Pelajaran : Fisika
 Kelas/Semester: XI/2
 Capaian Pembelajaran: Mampu menerapkan konsep fluida dinamis dalam kehidupan sehari-hari.

Materi	Fluida dinamis
Sub-materi	Persamaan kontinuitas fluida
Indikator Soal	Disajikan bacaan dan gambar/sketsa/rambu, siswa dapat menganalisis persamaan kontinuitas untuk situasi tersebut dan kapasitas persamaan gerak proyektil berdasarkan nilai yang didapat sebelumnya.

Level Kognitif: L3

Soal

Sebuah selang air bertekanan 2,5 cm digelakan oleh seorang tukang kebun untuk mengisi ember 30 L. Tukang kebun menyadari bahwa dibutuhkan waktu satu menit untuk mengisi penuh embernya. Sebuah alat penyemprot dengan lubang yang luasnya 0,500 cm² kemudian dihubungkan pada selang tersebut. Alat penyemprot itu diarahkan sehingga air keluar secara horizontal dari titik 1,20 m di atas tanah. Berapakah jangkauan horizontal dari air yang keluar?



MENU