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Development of A Diagnostic Test Instrument for Understanding Botanical Concepts for Biology Education Students

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ABSTRACT
The aim of this study was to describe the feasibility of a diagnostic test instrument that was developed based on expert judgment, validity test, and reliability test. This development research refers to the Borg & Gall model, but is limited to the fifth stage. The steps taken were: research and information collection, planning, developing preliminary form of product, preliminary field testing, and revising main product. The instrument prototype was validated by botanist and biology education expert. The prototype that has been validated was then revised and tested on 36 biology education students who have taken a botany courses. Test results were then used to measure the validity and reliability of the instrument. The validity of the instrument was tested with the Pearson Product Moment formula and t test. Instrument reliability was tested with the Spearman-Brown formula. The results of the study revealed that the developed diagnostic test instrument was feasible according to expert judgment. Nine items were valid and reliable, while one item was not valid.

Keywords: *Diagnostic test; Botanical concepts understanding; Biology education students.*

INTRODUCTION
Conceptual understanding has an important role in the teaching and learning process. Students must have a good understanding of concepts so that they do not experience misconceptions (Ariska et al., 2021) and achieve good learning outcomes (Amanda et al., 2022). For biology education students, the concepts of botany is one of the concepts that must be understood. Botany is a branch of biology that studies the structure, properties, physiological processes, and classification of plants (Steere et al., 2023). Identification of students' botanical concepts understanding can be done using a diagnostic test instrument.

Diagnostic tests can be used by teachers and lecturers to identify learning difficulties (Trinovitasari et al., 2022), misconceptions (Suparto et al., 2022), and the level of understanding of the students'concepts (Dewi et al., 2023). Diagnostic test instruments can be in the form of essay questions (Rinta & Fitriza, 2022) or multiple choice questions (Juliani et al., 2021). The diagnostic test instrument developed in this study is a two-tiers multiple choice question. Multiple choice diagnostic tests can have one to four tiers (Rusilowati, 2015). The one-tier test only presents the answer choices, while the two-tiers test presents the answer choices and the reasons (Pertiwi & Sholihah, 2019). The three-tiers test presents the answer choices, level of confidence in the answers, and the reasons for answering. The four-tiers test presents the answer choices, the level of confidence in the answers, the reasons for answering, and the level of confidence in the reasons given.

The type of test developed in this research is a two-tiers multiple choice test which presents the answer choices and their level of confidence. The advantage of this type of test is that it provides objective answers, id efficient in its implementation, and the level of confidence can be a way of identifying misconceptions (Diani et al., 2019). In addition, this type of diagnostic test has never been developed to identify understanding of botanical concepts by biology education students. Identification of botanical concepts understanding was generally carried out through analysis of cognitive test results during the midterm and final semester assessments (Adhani & Rupa, 2020). The purpose of this research is to describe the feasibility of a diagnostic test instrument that was developed based on expert judgment, validity test, and reliability test.

METHOD

This development research used five stages of the Borg & Gall model, namely: research and information collection, planning, developing preliminary form of product, preliminary field testing, and revising main product. In the first stage, the researcher conducted a needs analysis and information gathering. Needs analysis was carried out by interviewing lecturers teaching botany courses. Information collection was carried out through a literature review. In the second stage, the researcher determines the specifications of the diagnostic test instrument to be developed. The researcher conducted an expert validation test to assess the feasibility of the product in the third stage. The results of expert validation were analyzed descriptively. The instrument is declared quite valid and feasible to use if it reaches a minimum percentage of 70,01% (Akbar, 2017).

In the fourth stage, researchers conducted a limited trial involving 36 biology education students of Universitas KH. A. Wahab Hasbullah who has taken courses in botany in the 2021-2022 academic year. The results of this limited trial were used to test the validity and reliability of the instrument. Validity test using the Pearson Product Moment formula and followed by the t test. The significance level used was 0,05. Instrument items were declared valid if the calculated t value was greater than the t table value (Sundayana, 2018). Instrument items that were declared valid were then tested for reliability using the Spearman-Brown formula.

RESULT AND DISCUSSION

The results obtained in this study were expert validation data, validity and reliability test data of the developed diagnostic test instrument.

Result

The developed diagnostic test instrument meets the criteria of being quite valid according to the results of expert validation. Table 1 shows the results of the validation of material expert and Table 2 shows the results of the validation of biology education expert.

Table 1. Material Expert Validation Results

No.	Assessment Aspect	Score
1.	Items according to the indicator “able to identify botanical terms”	5
2.	Items according to the indicator “able to define botanical terms correctly”	5
3.	Items according to the indicator “able to understand the concept of botany”	4
4.	The botanical terms used are appropriate	4
5.	The botanical concept used is precise	4
6.	Items using the concept of structure, function, and classification of plants	3
7.	The item has only one correct answer	4
8.	The botanical concept used is in accordance with the achievements of botanical learning at the university	3
9.	The formulation of the items does not lead to multiple interpretations	4
10.	The formulation of the items uses good and correct language	4
Total		40
Percentage		80,00
Criteria		Quite Valid

Table 2. Biology Education Expert Validation Results

No.	Assessment Aspect	Score
1.	Filling instructions make it easier for test takers to work on test questions	4
2.	Items according to the specified indicators (able to identify botanical terms, able to define botanical terms correctly, able to understand botanical concepts)	3
3.	Items contain only one correct answer	5
4.	Items are not dependent on one another	5
5.	The formulation of the items does not point to the correct answer	5
6.	The formulation of the items using communicative sentences	5
7.	The formulation of the items does not contain negative statements	5
8.	The formulation of the items uses good and correct language	4
9.	The formulation of the items does not lead to multiple interpretations	4
10.	Homogeneous answer choices	3

No.	Assessment Aspect	Score
11.	The alternative answer lengths are the same	3
12.	Distractor works	4
13.	The location of the correct answer choice is determined randomly	4
14.	Correct spelling	4
15.	Correct grading rubric	4
Total		62
Percentage		82,67
Criteria		Quite Valid

The diagnostic test instrument which has been validated by experts and revised, is then tested on a limited basis to students. The results of this test are used to measure the validity and reliability of the instrument. Figure 1 shows the results of testing the validity and reliability of the instrument.

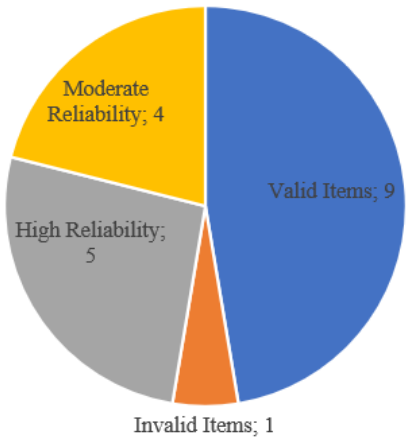

Figure 1. Validity and Reliability of the Instrument

Discussion

The results of the expert validation show that the developed diagnostic test instrument is feasible to use with a little revision because it obtains an average percentage of 81,33 (quite valid). The validator of the botanical subject matter expert gives the maximum score (score 5) for the suitability aspect of the items with the indicators “able to identify botanical terms” and “able to define botanical terms correctly”. However, the material expert validator gave a score of 4 for the suitability of the items with the indicator “able to understand botanical concepts”. These three indicators can be tested through questions of types C1 and C2. Type C1 questions relate to the ability to recall known terms or concepts, while type C2 questions relate to the ability to explain concepts that are already known (Wirandani et al., 2019).

There were more questions asking about botanical terms and their definitions than questions asking about botanical concepts in a comprehensive manner. This is the reason the validator gave a score of 3 for the assessment aspect number 6. Botanical concepts that must be mastered by biology education students are the concept of structure and function of plant organs, as well as plant classification (Steere et al., 2023). The concept of structure and function of plant organs can be studied in relation to the concept of plant physiology. Botanical material expert validators also provide suggestions for adding questions related to the concept of plant physiology. This suggestion could not be implemented due to time constraints.

Biology education expert validators give a score of 5 for aspects of assessment number 3 to 7 and a score of 4 for aspects number 8, 9, 12 – 15. This indicates that the items in the developed instrument meet the rules of good item construction (Uneputty et al., 2022). A good construction of multiple-choice questions has items that contain only one correct answer, each item is independent of one another, the formulation of the questions does not lead to the correct answer, does not contain multiple negative statements, and does not lead to multiple interpretations. Good questions use good and correct language with the correct grammar. The distractor must function and the location of the correct answer choice is determined randomly.

The biology education expert validator gave a score of 3 for the assessment aspect number 2, 10, and 11. The aspect number 2 relates to the suitability of the items with the specified indicators. Most of

the questions only accommodate the identification and definition terms, but do not accommodate understanding of botanical concepts. The aspect number 10 relates to the homogeneity of the answer choices. Homogeneous answer choices are homogeneous when viewed from a material perspective (Suhardi, 2022). For example, a question that discusses botanical terms for leaf, the answer choices must be terms about leaves. The aspect number 11 relates to the length of the answer choices. There are several questions that have different answer formulation lengths.

Instrument that has been validated and revised, tested for statistical validity. Validity is the value that determines a test is appropriate to measure what is measured (Hikmah & Muslimah, 2021). The results of the validity test showed that 9 items met the valid criteria and 1 item was invalid. Of the 10 items that were validates, only question number 10 was invalid. Question number 10 discussed plant physiological process, which was also suggested by the expert validator to add a variant to the problem. This result supports the results of the expert's assessment which states that the instrument is feasible to use with a little revision.

The nine valid items were then tested for reliability. Reliability is a value that determines the stability of an instrument (Setiyawan, 2014). 5 items have high reliability and 4 other items have moderate reliability. Items that have high reliability are items number 1, 2, 4, 8, and 9. Items that have moderate reliability are items number 3, 5, 6, and 7. The reliability of the items can be affected by the distribution of test scores, the higher the distribution of scores, the higher the reliability (Suparmin et al., 2012). Items that have high reliability have a more diverse distribution of scores than the moderate reliability items.

CONCLUSION

The diagnostic test instrument developed in this study meets the criteria of being quite valid based on the results of expert validation, so it is feasible to use with a little revision. The results of the validity test showed that there were 9 valid questions and 1 invalid question. The results of the reliability test of 9 items of the instrument showed that 5 items had high reliability and 4 items had moderate reliability. The invalid and unreliable item was item number 10.

REFERENCES

Adhani, A., & Rupa, D. (2020). Analisis pemahaman konsep mahasiswa pendidikan biologi pada matakuliah fisiologi tumbuhan. *Quantum: Jurnal Inovasi Pendidikan Sains*, *11*(1), 18–26.

Akbar, S. (2017). *Instrumen perangkat pembelajaran*. Remaja Rosdakarya.

Amanda, T., Fajri, S. R., & Hajiriah, T. L. (2022). Evaluasi pemahaman konsep mahasiswa pendidikan biologi pada materi pengetahuan lingkungan. *Jurnal Pedago Biologi*, *10*(1), 272–284.

Ariska, M., Akhsan, H., Muslim, M., & Azizah, S. N. (2021). Pemahaman konsep awal mahasiswa pendidikan fisika terhadap materi benda-benda langit dalam perkuliahan astrofisika. *Jurnal Ilmiah Pendidikan Fisika*, *5*(3), 405–413. https://doi.org/10.20527/jipf.v5i3.3523

Dewi, R. A., Haryati, S., & Aldresti, F. (2023). Analisis kesulitan pemahaman konsep peserta didik pada pokok bahasan kesetimbangan kimia menggunakan instrumen tes diagnostik four-tier multiple choice. *Jurnal Pendidikan Kimia Universitas Riau*, *8*(1), 43–49. https://doi.org/10.33578/jpk-unri.v8i1.7836

Diani, R., Alfin, J., Anggraeni, Y. M., Mustari, M., & Fujiani, D. (2019). Four-tier diagnostic test with certainty of response index on the concepts of fluid. *J. Phys.: Conf. Ser.*, *1155*(012078), 1–9. https://doi.org/10.1088/1742-6596/1155/1/012078

Hikmah, & Muslimah. (2021). Validitas dan reliabilitas tes dalam menunjang hasil belajar PAI. *Proceedings of Palangka Raya International and National Conference on Islamic Studies*, 345–356.

Juliani, Yusrizal, & Huda, I. (2021). Development of four-tier multiple choice diagnostic tests to know students' misconceptions in science learning. *Jurnal Penelitian Pendidikan IPA*, *7*(4), 763–769. https://doi.org/10.29303/jppipa.v7i4.854

Pertiwi, N. A. S., & Sholihah, F. N. (2019). Melatih Kemandirian Mahasiswa Melaksanakan Praktikum Elektronika Dasar I Menggunakan Media Praktikum Melalui Optimasi Kecerdasan Visual Spasial. *JoEMS (Journal of Education and Management Studies)*, *2*(4), 1-6.

Rinta, C., & Fitriza, Z. (2022). Pengembangan tes diagnostik esai terstruktur kimia materi titrasi asam basa sebagai instrumen analisis hasil belajar siswa. *Edukimia*, *4*(2), 84–89. https://doi.org/10.24036/ekj.v4.i2.a353

Rusilowati, A. (2015). Pengembangan tes diagnostik sebagai alat evaluasi kesulitan belajar fisika.

Prosiding Seminar Nasional Fisika Dan Pendidikan Fisika Ke-6, 1–10. https://media.neliti.com/media/publications/173335-ID-pengembangan-tes-diagnostik-sebagai-alat.pdf

Setiyawan, A. (2014). Faktor-faktor yang mempengaruhi reliabilitas tes. *Jurnal An Nur*, *6*(2), 341–354.

Steere, W. C., Pelczar, R. M., & Pelczar, M. J. (2023). *Botany*. Encyclopedia Britannica. https://www.britannica.com/science/botany

Suhardi, I. (2022). Perangkat instrumen pengembangan paket soal jenis pilihan ganda menggunakan pengukuran validitas konten formula Aiken's V. *Jurnal Pendidikan Tambusia*, *6*(1), 4158–4170.

Sundayana, R. (2018). *Statistika Penelitian Pendidikan*. Alfabeta.

Suparmin, Bakar, U. A., Giyoto, & Fauzi, A. (2012). Validitas, reliabilitas, dan kepraktisan ujian melalui observasi dan bentuk lisan bagi kelas besar pada prodi pai fakultas tarbiyah dan bahasa IAIN Surakarta. *Kodifikasia*, *6*(1), 65–76.

Suparto, Kusaeri, & Ningsih, A. (2022). Pengembangan four-tier diagnostic test untuk mengidentifikasi miskonsepsi materi segitiga. *Transformasi: Jurnal Pendidikan Matematika Dan Matematika*, *6*(1), 61–74. https://doi.org/10.36526/tr.v%vi%i.1941

Trinovitasari, F., Silitonga, H. T. M., & Hidayatullah, M. M. S. (2022). Pengembangan tes diagnostik menggunakan model teslet untuk mengidentifikasi kesulitan belajar peserta didik SMA pada materi materi momentum dan impuls. *Variabel*, *5*(2), 57–66. https://doi.org/10.26737/var.v5i2.3091

Uneputty, V., Huliselan, E., & Malawau, S. (2022). Analisis Standar Perencanaan Penilaian, Kaidah Penulisan Soal dan Kriteria Butir Soal Pilihan Ganda Tes Sumatif Fisika Kelas X Pada SMA Kristen 1 Amahai, Kabupaten Maluku Tengah. *PHYSIKOS Journal of Physics and Physics Education*, *1*(1), 38–45. https://ojs3.unpatti.ac.id/index.php/physikos/article/view/6065

Wirandani, T., Kasih, A. C., & Latifah. (2019). Analisis butir soal HOTS (high order thinking skill) pada soal ujian sekolah kelas XII mata pelajaran Bahasa Indonesia di SMK An-Nahl. *Parole: Jurnal Pendidikan Bahasa Dan Sastra Indonesia*, *2*(4), 485–494.