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The Analysis of Barriers to the Use of Physics Practicum Applications

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Abstract:
This research aims to analyze the conflicts or obstacles faced by students and physics teachers in carrying out physics practicum activities at SMP Negeri 5 Jambi City. This Research Means Narrative Research Using Mix Method. The sample in this study was 35 students and two subject physics teachers. Data Collection Using Angel Teachers and Students About Physics Practicum Applications And Interview Guide Sheets To Teachers. This study uses narrative statistical analysis techniques for quantitative data and uses the example of Miles and Huberman for qualitative data. The research results based on the questionnaire of students and teachers showed that the implementation and assessment of the physics practicum and student motivation were in a suitable category, while the teacher's motivation was in a bad category. Then from what will happen in the interview, problems are obtained in the implementation of the physics practicum, namely the laboratory room, which is still used as a shared room, not enough time to carry out the practicum, the lack of teacher motivation, and the number of practicum senses that are less evenly distributed.

INTRODUCTION

Physics is a part of science, meaning knowledge that has been systematically arranged, organized, produced through observation and experimentation and is useful for humans. Referring to this understanding, it is clear that physics must be started by conducting observations and experiments(Allotey et al., 2017; Barbara & Kitchenham, 2019), which means that the process is very important regarding how to acquire knowledge (Sundoro, et al, 2013). The Laboratory Is An Area Room To Do Practical Or Research Activities That Are Supported By The Existence Of A Set Of Laboratory Equipment And A Complete Laboratory Infrastructure. Furthermore, according to Dian (2016) in the laboratory, students will gain new knowledge and understanding through experiments carried out, even a systematic learning process that leads to targets that can be carried out in the laboratory. Based on the Regulation of the Minister of Education and Culture No. 32 of 2013 concerning the National Education Book, that the laboratory is one of the standard vehicles needed by schools to support a learning process (Goodhew et al., 2019; Kemendikbud, 2017; Margot & Kettler, 2019). And As According to the Regulation of the Minister of National Education No. 24 of 2007 concerning the Standards for Facilities for Infrastructure, states that one of the necessary and must-have

vehicles for every educational unit is the availability of a laboratory to support the success of observation and experiment activities.

Even this laboratory activity has its contribution to what results in student learning, which results in student learning being grouped into three domains, namely cognitive, affective, and psychomotor. The cognitive domain includes mental activities, while the affective domain includes behavioral traits such as feelings, interests, attitudes, emotions, and values. According to Leighbody in Sundoro (2013), he argues that the evaluation of psychomotor learning includes (1) the ability to use the senses and work attitudes, (2) the ability to analyze a job and then arrange the sequences of work attitudes (3) the speed of doing tasks, (4) the ability to read Images and symbols, and (5) the compatibility of the shape or size that has been determined. The point is that practice or practicum is a form of teaching and learning activity that is intended to strengthen the mastery of applicable material. Through Independent, Guided Activities, and Utilization of Optimal Practice/Practicum Vehicles as a Whole Unit in the Practicum Implementation System, it is necessary to be able to achieve a learning goal well. According to Rustaman Pada Novita (2015) stated that generally experts are of the opinion that practicums can support students' understanding of science learning materials. In Permendiknas No. 41 of 2007, Learning Process Planning Includes Syllabus and Learning Application Planning (RPP) That Produces Subject Characteristics, Competency Standards (SK), Basic Competition (Kd), Competency Achievement Indicators, Learning Objectives, Teaching Materials, Time Allocation Learning Methods , Learning Activities Assessment As a result of Learning Origin of Learning. Based on Permendiknas No. 41 of 2007, the learning application is the implementation of the lesson plan. Implementation of Learning Includes Preliminary Activities, Core Activities, Epilogue Activities. According to Permendiknas No.20 of 2007, Educational Evaluation is a Process of Gathering and Processing News to Determine the Achievement of Student Learning Outcomes. Evaluation of Student Learning Consequences is Conducted in accordance with Nationally Applicable Education Evaluation Standards (Chou et al., 2013; Margot & Kettler, 2019; Thees et al., 2020). In Permendiknas No. 41 of 2007, Assessment of the Learning Process at the Elementary and Secondary Education Levels Uses Various Assessment Techniques In Accordance With The Basic Competencies That Must Be Mastered. Based on the 2008 Ministry of National Education, there are several evaluations or assessments in learning

These characteristics include (1) an assessment system using continuous tests/exams with the provisions of the test being carried out to see the completeness of each basic competency; (2) the test can be carried out for one or more basic competencies. (3) What will happen in the test is analyzed and followed up through a remedial program, enrichment program (4) the test includes cognitive and psychomotor aspects; And (5) Affective Aspects Measured Through Affective Inventory Activities Similar to Observations, and General News. Furthermore, according to Setyaningrum (2013), practicum provides an opportunity for students to prove the theory, find theory or evaluate the theory. The effectiveness of practicum implementation is not only imposed on teachers, but the most important thing is where students come from. Materials that are

willing and their behavior towards processing the time given so that the physics practicum has several benefits in student life. But in reality, practicums are still often not carried out by teachers in schools. According to Gabel and Edi (2014), the problems teachers face in conducting practicums include, among others, the lack of equipment and practicum materials and the lack of knowledge and skills of teachers in managing practicum activities. In addition, the absence of an assistant who helps teachers and too many students makes it difficult to regulate the activity process. The level of effectiveness in conducting practicum is determined by the quality of resources, including the quality of educators and the completeness of the laboratory.

What's more, quality activity planning and perfect assessment tactics. Apart from that, previous research conducted by Sundoro (2013) and stating that the obstacles for teachers in carrying out laboratory activities are besides the absence of energy for laboratory technicians/physics laboratory technicians, there is still a lack of understanding of physics teachers about the importance of innovation in learning to develop norms for critical thinking skills (Aviani et al., 2015; San Martín & Rolin, 2013). As well as sharing the habit of scientific thinking in science education, there is still a laboratory room that is used as a study area; even the physics laboratory room is still joined to the chemistry and biology laboratory room, it is not enough when doing practicum by utilizing the existing facilities. Practicum with Moderate Facilities.

The research has also conducted previous observations in two schools, SMP 23 Jambi City and SMP 5 Jambi City. The interviews of the two physics teachers from each school resulted in the cause of school teachers rarely doing physics practicums because of the lack of availability of practicum senses which became an obstacle to the implementation of practicums for each school. The Physics Laboratory Room is also still joined to the room along with the practicum equipment, whose numbers are not evenly distributed. Some exclusive sensory devices are still incomplete, so it becomes an obstacle to reviewing the application of the physics practicum at the school earlier. By this explanation, the researcher considers it necessary to examine in more depth how the physics practicum is carried out, especially at SMP5 Jambi City and what the obstacles are in the implementation of the physics practicum, but the continuity that is obtained when the observations are carried out. This Research Aims To Analyze Conflicts Or Barriers Faced By Students And Physics Teachers In Carrying Out Physics Practicum Activities At SMP 5 Jambi City. Physics at SMP Negeri 5 Jambi City. Teachers to be able to correct deficiencies in the implementation of future mass practicum activities. The Government is Expected To Be Able To Contribute Thoughts To The Government As A Solver Of The Problems And Problems That Emerge. Decision Policy Makers, As Considerations In Improving Laboratory Room Conditions For More Physics Practicum Applications In The Future.

METHOD

This Research Is A Descriptive Research Using Concurrent Mixed Methods Approach. In this design, the researcher collects both forms of data simultaneously during the study and then integrates the information into the interpretation of a broader

range of effects. This Approach Uses Research Strategies That Will Affect Data Collection Simultaneously Or Sequentially To Find The Best Research Cases. Data Collection Also Affects Information Both Numerical (Through Instruments) Or Information Such As Text (Through Interviews). As A Result, The Final Database Represents Either In The Form Of Quantitative News Or Qualitative News. In Mixed Methods Approach Using Dough 2 Approaches, namely Qualitative Approach, and Quantitative Approach Or Can Be Claimed Also Using Dough Research. So The Researcher Determines By Using This Mix Methods Approach (Ary, Donald; Jacob Lucy Cheser; Sorensen, Cris; Razavieh, 2010) To Answer The Problems That Have Been Included In The Background And Using Concurrent Triangulation Tactics. (Johnston, 2014) states that in this strategy, researchers collect quantitative and qualitative data simultaneously in the research step, then compare the two data to find out the differences or combinations. Population Research Subjects Are Generalized Subject Areas With Exclusive Characteristics To Be Learned And Draw Conclusions. The target population in this study can be interpreted that all the teachers who teach physics lessons totaling two people, and all students at the State Junior High School 5 Jambi City with 360 members. So from the origin of the population, the researcher determines the research sample using the purposive sampling technique Sugiono (2016) states that purposive sampling is a sampling technique with exclusive considerations. So what the researchers consider in determining the sample are 1) State Junior High School 5 Jambi City students. 2) Students Must be in Class VIII. 3) Students must have done practicum before. If the sample has met these conditions, it can be used as a sample to be used for research in the study, meaning that all students in class VIII who have done practicum include 70 people from a total population of 360 people.

The data source used is a mixed approach, so there are two methods of data collection carried out in this study: 1) Quantitative data, obtained from questionnaire data on teacher and student responses in practicum implementation. 2) Qualitative data in this study was obtained from interviews using the Interview Agreement Formular Sheet and Interview Question Sheets for Subject Teachers at Smpn 5 Jambi City Regarding Teaching Constraints on Practicum Implementation and Documentation Results from Teachers Who Have Implemented Practicum.

Research Instruments in this study used four instruments in order to obtain research data, namely Interview. (1) Interviews were conducted with the sample teachers, namely all Class VIII Teaching Teachers Teaching Science at SMPN5 Jambi City. Before the interviews were conducted, the teachers were given a pre-interview approval form adapted from Novi and Lisa's research. (2) Documentation Most of the information and data are stored in materials as documentation. The primary nature of this data is not limited to space and time, so it gives researchers the opportunity to find out what happened in the past. Then the documentation instrument can be used in research because the research does not directly observe the practicum carried out by the teacher but only takes data after the teacher carries out the practicum. As a result, documentation is needed to know the news of the practicum that has been carried out.

Data Analysis (Quantitative Data Analysis). Quantitative Data Analyzed With Neural Statistics. The data obtained from the questionnaire responses to the practicum were analyzed using descriptive statistics. The Questionnaire used in this study used the Guttman Evaluation Scale Newsletter as follows: (a). The score that will occur in the teacher and student response questionnaire on positive statements using the answer "yes" is worth 1, and the answer "no" is worth 0. (b). Scores Due to Questionnaire Teacher and Student Responses on Negative Statements Using "No" Answers are Worth 1, And "Yes" Answers Are Worth 0.

Next, Calculate the Percentage of Teacher and Student Response Questionnaire Scores Using the $\%=\frac{n}{N}X100\%$

Description

N = Scores Obtained by Sample Teachers and Student Representatives.

N = Total Score That Sample Teachers and Student Representatives Should obtain.

% = Percentage of Activities Conducted by the Sample Teacher and Student Representatives.

Then Calculate The Percentage Of Homogeneous Average For Each Aspect, Using The Formula: Percentage Homogeneous-Homogeneous = Total / Score / Obtained / X100% Divided by Total / Respondents / Riduan (2015) states that the Guttman Scale used in the Practicum Implementation Questionnaire Respondents' answers can be in the form of the highest score (1) and the lowest score (0), and there are only two intervals on the Guttman Scale, namely: True (B) and False (S). As a result, the Interpretation Criteria for Scores in the Questionnaire Conducted in this Research Peda are as follows: Interpretation Criteria Score 0% - 49% = Not Good and 50% - 100% = Good. Riduan (2015) states that the Guttman Scale used in the Practicum Implementation Questionnaire Respondents' answers can be in the form of the highest score (1) and the lowest score (0), and there are only two intervals on the Guttman Scale, namely: True (B) and False (S). As a result, the Interpretation Criteria for Scores in the Questionnaire Conducted in this Research Peda are as follows: Interpretation Criteria Score 0% - 49% = Not Good and 50% - 100% = Good. Riduan (2015) states that the Guttman Scale used in the Practicum Implementation Questionnaire Respondents' answers can be in the form of the highest score (1) and the lowest score (0), and there are only two intervals on the Guttman Scale, namely: True (B) and Wrong (S). As a result, the Interpretation Criteria for Scores in the Questionnaire Conducted in this Research Peda are as follows: Interpretation Criteria Score 0% - 49 If the data has been calculated in a homogeneous-homogeneous percentage of the indicators that are in the Questionnaire, then each indicator is analyzed including the Interpretation Criteria for the score. Good or Bad, And Finally Analyzed Using Diagrams.

Qualitative Data Analysis The data comes from interviews. Teacher responses were analyzed descriptively using the Miles and Huberman models. The example shows that the steps used in the data analysis technique are data reduction, data samples, and conclusion drawing (Emzir, 2011). (a) Data Reduction Sugiono (2016) states that reducing data means summarizing, choosing essential things, and looking for themes and

patterns. Then the reduced data will provide more apparent illustrations and make it easier for researchers to carry out data collection. Reducing the data in this study means that the data from the interview results of the teacher's responses regarding the constraints of the Ekamatra practicum are summarized, then the critical things are taken, and a pattern is made. (b) Data Display Then Sugiono (2016) stated that after the data was reduced, the next step was to present the data. If in quantitative research, data presentation can be done in the form of tables, graphs, phi chard, pictograms, or the like. Through the presentation of the previous data, the data is organized and arranged in a correlation pattern so that it is easier to understand. By presenting the data, it will be easier to understand what has happened by planning work and according to what has been understood earlier. The data that has been presented is data from the results of teacher interviews that have been reduced, and then the data is concluded. 0-49% = Not Good And 50% - 100% = Good. Conclusion Drawing / Further Verification Sugiono (2016) states that the third step in qualitative data analysis based on Miles and Huberman is drawing conclusions and proofs. The conclusions raised are still temporary or not permanent; they will change if no substantial evidence is found to support them in the first step, supported by valid or consistent evidence when the researcher returns to the field to collect data; then the conclusions found are Reliable Conclusion.

RESULT AND DISCUSSION

The study was conducted at the end of October 2021 at SMPN 5 Jambi City. This Research Uses Instruments In Collecting Data In The Form Of Questionnaires And Interview Guidelines. Two questionnaires are used in this study, namely a questionnaire that focuses on the teacher and a questionnaire distributed to students. The Questionnaire was compiled using the Guttman scale in this study to obtain data on how the Ekamatra practicum activities at SMPN 5 Jambi City were by the research objectives. Students who become research samples will ask questions about whether there are obstacles in the implementation of physics practicum or if there are no obstacles in the application of physics practicum. Meanwhile, the interview guide used to interview teachers was used as a sample to provide information about teacher barriers to implementing the physics practicum at Smpn 5 Jambi City. Then the research data that has been obtained will then be processed to find out the results of the answers from all samples and the average results of the answers to each question. And the results of the data will be presented to know the results of the data in each category that has been designed.

Student Questionnaires' Results on the Physics Practicum Implementation at Sma Negeri 5 Jambi City.

Based on the results of the research on the implementation of the physics practicum, using a questionnaire instrument that has been filled in by students of the science department totaling 30 statements with three negative sentences and 27 positive sentences. Research Data Obtained, Processed To Get The Number Of Sample Answers And The Average Of Each Statement. The Average Results Are Directed To Classification Of Sample Categories In Searching For Answers To Research Questions.

The answer is the conclusion of each statement item to determine the level of the category of physics practicum implementation, motivation, and evaluation. The following will present the results of grouping based on indicators.

Table 1. Average Percentage of Student Questionnaire Indicators About the Implementation of Physics Practicum

No	Indicator	Average	Percentage	Criterea
1	Practical Implementation	88	62%	Good
2	Motivation	90	61,9%	Good
3	Evaluation	90	61%	Good

All Indicators Generate Percentages That Include Good Categorical, Categorical Obtained From Questionnaires Using The Guttman Scale Only Has A Range Of 0 To 1, So The Guttman Scale There Are Only Two Intervals, That Is Good And Not Good. Results that fall into the range from 0 to 0.49 are categorized as wrong, while results that fall from 0.5 to 1 are categorized as good. In the table, it can be seen that the implementation of the physics practicum is categorized as good; it can be seen in the teacher's worksheet that the implementation is very well designed. The motivation of Amount is also categorized as good, which means that the motivation of students in carrying out the practicum is categorized as good. Then the evaluation of the students in carrying out the practicum is also categorized as good, which means that the evaluation experienced by the students when carrying out the practicum is quite good. To draw a clearer picture of the percentage of the overall average results in the Physics Practicum Implementation Questionnaire at SMP Negeri 5 Jambi City, it can be seen in the analysis, namely: Evaluation 61.00%, Practicum Implementation 62.00%, and Motivation 61.90% Results of the Percentage of Average Results of Student Questionnaires on the Implementation of Physics Practicum. 39% evaluation, 38.00% practicum implementation and 38% motivation. Results of the Average Percentage of Obstacles to the Implementation of Physics Practicum. Results of Teacher Questionnaires on the Implementation of Physics Practicum at SMP Negeri 5 Jambi City. Based on the results of research from the implementation of science practicum activities, using a questionnaire instrument that has been filled out by science teachers at SMP Negeri 5 Jambi City, totaling 24 statements. The results of the questionnaire can be seen in Table 2

Table 2. Results of Questionnaire Implementation of Science Practicum Activities

No	Indicator	Average	Percentage	Criterea
1	Practical Implementation	0,56	56 %	Good
2	Motivation	0,25	25 %	Good
3	Evaluation	0,50	50%	Good

The Percentage of Average Results of Practicum and Evaluation Implementation Indicators is Included in the Good Category. In contrast, the Percentage of Average

Results of Motivation Indicators is Included in the Bad category. To describe more clearly the percentage of the overall average results of filling in teacher questionnaires in the implementation of physics practicum at Sma Negeri 5 Jambi City. Average Results of Teacher's Questionnaire About the Implementation of Physics Practicum. 50% evaluation, 56% practicum implementation and 25% motivation. Description of Physics Teacher Interview Results About the Implementation of Physics Practicum at SMP Negeri 5 Jambi City. Based on the results of interviews conducted with physics teachers at SMP Negeri 5 Jambi City, there were 25 questions and almost different results. During the interview, there were two Physics Subject Teachers who provided information about the implementation of physics practicum as shown in the table above; the first teacher carried out practical activities in third grade with material on light diffraction and light interference and from the results of interviews with the first teacher as shown in The table above can be concluded that he has carried out the physics practicum well. In terms of the stages of practicum implementation, he introduces the tools first. In terms of preparation, he is assisted by laboratory assistants, and for his evaluation, there is already a self-assessment sheet for students. This can be adjusted to the teacher's implementation plan (RPP) and student worksheets (LKS) that the teacher has made according to the curriculum used in schools, namely the 2013 curriculum.

His Obstacles In Carrying Out Physics Practicums, Because The Laboratory Is Also A Shared Room, So When Carrying Out Practicums You Have To Take Turns With Other Teachers. As for the obstacles in carrying out the practicum, he finds it difficult to control the students who are too enthusiastic about the practicum; it hinders the practicum. Then the Obstacles In Evaluating Practicum Activities, namely in assessing the practicum reports that students have made, most students copy the reports of their friends, so it is difficult to assess student reports per individual. Furthermore, the second teacher did not carry out the practicum due to constraints at the time of its implementation; the time was not enough to carry out the practicum because it was divided into two shifts so that the teacher taught more in class to pursue the material and did not have time to do physics practicum. His obstacle in its implementation is that it often lacks specific tools, the physics practicum tools in schools are by the standards, but there are still shortages of specific tools and tools that are in excess. As for the evaluation, the difficulty of teachers in conducting evaluation assessments is because students are still not serious about making practicum reports.

Description of the results of the answers to the student questionnaire essay about the implementation of physics practicum at SMP Negeri 5 Jambi City

Based on the results of the Essay Answers on the Student Questionnaire filled out by the Mathematics and Natural Sciences students, there are four questions, and they are divided into three topics, namely: (a) Frequency of doing a practicum in one month. Practicum In One Month That Is 1-2 Times In One Semester, The Implementation Of The Practicum Is Done In Classrooms, And Not In The Physics Laboratory. (b) Practicums That Have Been Conducted on Electrical Energy Materials Practicum Activities For Class IX Science Have Been Conducted, While Classes VIII and IX Have

Never Conducted Practicums in the Last Semester. (c) Obstacles to Practicum Implementation The main obstacle to implementing a physics practicum at SMP Negeri 5 Jambi City is that the physics laboratory has been used as a standard room, so students do not do a practicum in the physics laboratory can only do a practicum in class.

CONCLUSION

From the results of the research conducted regarding the obstacles to the implementation of the physics practicum at SMP Negeri 5 Jambi City, it can be concluded that the implementation of the physics practicum based on the questionnaire responses from teachers and students can be concluded that the implementation of the physics practicum in schools has been carried out well, and the evaluation of the practicum that has been carried out has also been carried out well. But Physics Teachers at SMP Negeri 5 Jambi City are still less motivated in carrying out physics practicum, while students in the science department are more motivated and enthusiastic if physics learning is carried out in physics practicum implementation. Problems that become obstacles in the implementation of physics practicum at SMP Negeri 5 Jambi City, namely the laboratory room, which is still used as a shared room so that it is difficult to carry out practicum in the physics laboratory and practicum is often carried out in classrooms, not enough time to carry out practicum, there is still a lack of teacher motivation in implementing Physics Practicum, As well as the Uneven Number of Practicum Tools for Per Physics Material. In the next practicum, the teacher improves and pays attention to evaluation activities such as evaluating reports on student observations so that students better understand reporting and their relationship with the subject matter. Further research can be carried out in other 5 public junior high schools in Jambi City that have not been studied, namely private junior high schools that rarely or never carry out physics practicum.

REFERENCES

Allotey, P., Allotey-Reidpath, C., & Reidpath, D. D. (2017). Gender bias in clinical case reports: A crosssectional study of the “big five” medical journals. *PLoS ONE*, *12*(5), 1–8. https://doi.org/10.1371/journal.pone.0177386

Ary, Donald; Jacob Lucy Cheser; Sorensen, Cris; Razavieh, A. (2010). *Introduction to Research in Education* (C. Shortt (ed.); Eighth). Wadsworth, Cengage Learning.

Aviani, I., Erceg, N., & Mešić, V. (2015). Drawing and using free body diagrams: Why it may be better not to decompose forces. *Physical Review Special Topics - Physics Education Research*, *11*(2), 1–14. https://doi.org/10.1103/PhysRevSTPER.11.020137

Azhar. 2008. Pendidikan Fisika Dan Keterkaitannya Dengan Laboratorium. Jurnal Geliga Sains: Volume 1.

Barbara, & Kitchenham. (2019). Service function chaining across openstack and kubernetes domains. *DEBS 2019 - Proceedings of the 13th ACM International Conference on Distributed and Event-Based Systems*, 240–243. https://doi.org/10.1145/3328905.3332505

Chou, J. S., Tsai, C. F., & Lu, Y. H. (2013). Project dispute prediction by hybrid machine learning techniques. *Journal of Civil Engineering and Management*, *19*(4), 505–517. https://doi.org/10.3846/13923730.2013.768544

Creswell, J. W. 2010. Research Design: Pendekatan Kualitatif, Kuantitatif, Dan Mixed. Yogjakarta: Pt Pustaka Pelajar.

Dian, Eka. 2016. Analisis Sarana Prasarana Laboratorium Fisika Dan Intensitas Kegiatan Praktikum Fisika Dalam Mendukung Pelaksanaan Pembelajaran Fisika SMP Negeri Di Kabupaten Jember. Jurnal Pembelajaran Fisika: Volume 5 Nomor 1.

Edi, Daenuri. 2014. Pelatihan Pembuatan Alat-Alat Praktikum Ipa Fisika Bagi Guru Ipa Smp/Mts Swasta Se-Kecamatan Winong Kabupaten Pati. Volume 14 Nomor 1.

Emzir. 2015. Metodologi Penelitian Pendidikan Kualitatif Dan Kuantitaif. Jakarta: Rajawali Pers.

Goodhew, L. M., Robertson, A. D., Heron, P. R. L., & Scherr, R. E. (2019). Student conceptual resources for understanding mechanical wave propagation. *Physical Review Physics Education Research*, *15*(2), 20127. https://doi.org/10.1103/PhysRevPhysEducRes.15.020127

Johnston, J. S. (2014). John Dewey and science education. In *International Handbook of Research in History, Philosophy and Science Teaching*. https://doi.org/10.1007/978-94-007-7654-8_75

Kemendikbud. (2017). *Panduan Praktis Penyusunan E-Modul*. 1–57.

Margot, K. C., & Kettler, T. (2019). Teachers' perception of STEM integration and education: a systematic literature review. *International Journal of STEM Education*, *6*(1). https://doi.org/10.1186/s40594-018-0151-2

San Martín, E., & Rolin, J. M. (2013). Identification of parametric Rasch-type models. *Journal of Statistical Planning and Inference*, *143*(1), 116–130. https://doi.org/10.1016/j.jspi.2012.06.014

Thees, M., Kapp, S., Strzys, M. P., Beil, F., Lukowicz, P., & Kuhn, J. (2020). Effects of augmented reality on learning and cognitive load in university physics laboratory courses. *Computers in Human Behavior*, *108*, 106316. https://doi.org/10.1016/j.chb.2020.106316