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Validity of Chemo-entrepreneurship Teaching Material to Analyze Students' Cognitive in Redox Reaction

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Abstract

Chemo-entrepreneurship or CEP known as learn chemistry with an entrepreneurial approach to made products. Teachers in research school only use provided books by schools and materials on internet, so it is necessary to develop effective teaching material that fits main purpose. There also need to develop learning media to train student's ability from interdisciplinary approaches. The aim of this research is to develop chemo-entrepreneurship teaching materials that appropriate and effective to analyze students' cognitive. This is Research and Development method with ADDIE model. Data collection methods are by observation, questionnaires, tests, and project methods. Data analysis techniques include analysis of interview sheets, instrument validation, analysis the effectiveness of teaching materials, and analysis of questionnaire responses. The result is 87% of students pass the minimum score, means most students pass the achievement and have good cognitive abilities. There are 26 passed students and 4 not passed. Teaching materials get validity score 49 of 52. Teaching materials get positive responses from teachers with score 35 of 40 and positive responses from students with an average score of 38.53 of 48. It means that developed material book appropriate and effective to help teacher explain chemistry with interdisciplinary approaches.

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INTRODUCTION

Indonesian Central Bureau of Statistics in 2015, 2016, and 2017 noted that every year there is an increase in workers with high school graduates which are almost one million people (Badan Pusat Statistik, 2016, 2017), made high competitiveness due to it. Then lack of employment opportunities makes people open entrepreneurial activities (Windsor et al., 2014) that stated in Micro, Small and Medium Enterprises (UMKM) that almost increased in each year from 2016 to 2018 by 1.2 million new businesses (Depkop, 2017, 2018). It means that the community has an interest in entrepreneurial activities, and it would make fierce product competition made it, so there is a need for learning about entrepreneurship. Entrepreneurship can be given to students as a debriefing to prepare their skill (Hasanah & Ratumbuysang, 2017) in the form of entrepreneurial skills that provide a lot of experience and benefits for students, especially adequate skills (Carnawi et al., 2017).

The orientation of chemistry education is now starting to develop students' thinking skills, namely by connecting chemistry with other materials or other disciplines where students hope that they will be able to help solve global problems (Nagarajan & Overton, 2019). Chemo-entrepreneurship is one of the chemical learning methods that aims to train students soft skills and motivate students to think creatively through scientific project activities that produce an innovative entrepreneurial work (Supartono, 2006). The experimental method in a project can motivate students about how the knowledge they gain can be formed and synergized (Joyce et al., 2015). Entrepreneurial activities in chemistry learning can develop students' creativity and cause active classroom conditions, so that learning becomes more concerned (Wibowo & Ariyatun, 2018), while at the same time attracting students' interest in the world of entrepreneurship (Arieska & Kamaludin, 2018).

Teaching materials are learning aids that contain the application of science, information, and examples of the application of science in everyday life that can be used in the classroom or at home (Arsyad, 2011). Transfer of knowledge through teaching materials depends on how students can understand the material provided by teaching materials (Rizqiana et al., 2017). Good teaching materials have several components, including cover pages, identity, introduction, table of contents, instructions for using books, basic competencies and indicators, concept maps, materials, assignments, summaries, evaluations, and closings (Arieska & Kamaludin, 2018). CEP can be integrated in learning process using teaching materials (Prayitno et al., 2017).

Field study in Madrasah Aliyah 1 Kota Semarang told that learning still need to be studied because students haven't passed minimum standard. Only 9 from 30 students in the X MIPA 1 that passed the minimum standard in daily test. There should be a problem that made students not passed minimum standard. Also, they don't have creativity evaluation, so it should need attention because students don't have enough creativity, then they are didn't respectful to the material. So the development of entrepreneurship oriented learning was needed to build students creativity (Afwa et al., 2018).

Field study in Madrasah Aliyah 1 Kota Semarang also shows that chemistry teachers haven't develop their learning materials. It would better to develop their learning materials based on what teachers and curriculum want from students (Alfiantara et al., 2016; Nurbaeti, 2019). Also students cognitive are categorized "high" after study using chemistry teaching material (Sunarya et al., 2018), and 88% of students pass the minimum score after studying chemistry using chemo-entrepreneurship media (Sumarti et al., 2018).

Based on the above gaps, it is necessary to develop a lesson, manual, or reference that can be used to improve the quality of human resources in entrepreneurship activities. The development of teaching materials can also be used as a basis for knowledge to start a business. It can even be used as a training and evaluation of students' cognitive on entrepreneurial chemistry

METHODS

The research method is research and development by following the ADDIE model development research design with five stages (Dick et al., 2008). The research stages include: (1) the analysis phase, (2) the design

phase, (3) the development phase, (4) the implementation phase, and (5) the evaluation phase. The research location was carried out at Madrasah Aliyah Negeri 1 Kota Semarang from January to May 2021. The research subjects consisted of teachers, students of class X MIPA 1, and expert validators. The ADDIE research procedure has been modified so that each stage has an evaluation session. Evaluation is used to correct deficiencies at each stage (Dick et al., 2008). Descriptions on each stage stated below.

Analysis phase begins with field observations through interviews. The results of the interviews are used for problem and needs analysis. Design phase begins with determining the research subject matter, making a research flow chart, and assessing the concept of teaching materials developed. The topic of discussion is the topic of redox reactions and the nomenclature of chemical compounds for class X in even semesters. The research flow chart is designed according to the research flow, starting from field observations, analysis of problems and needs, the process of designing teaching materials products, product validation and testing processes, product implementation, data analysis of research results, and drawing conclusions.

Development phase begins with designing the concept of teaching materials, syllabus, lesson plans, evaluation tools, validation processes, and the trial phase. Design of teaching materials and other devices is validated by experts to assess the feasibility of the design of teaching materials before the trial. Design of teaching materials that have been declared feasible to be tested to get input so that they can be improved before the implementation stage is carried out.

Implementation stage is the stage of applying teaching materials to research subjects, namely students of class X MIPA 1. Learning is carried out using the project method that produces products. Entrepreneurship projects are planned and designed by students whose output is in the form of value-added entrepreneurial products related to redox reactions. Then in the last meeting, students had a daily test. The result of daily test used to analyze students' cognitive ability from the learning. Evaluation stage is used as an evaluation of each stage, besides that it is also a stage to find out the strengths and weaknesses of chemo-entrepreneurship-oriented teaching materials that developed based on the responses of students and teachers as users through a questionnaire.

The instruments used in the study included teacher and student interview guide sheets, teaching materials instruments, syllabus, and lesson plans, instrument validation sheets, questionnaire responses, and daily test sheets. The effectiveness of teaching materials is seen from the analysis of the daily test of students. Teaching materials are declared effective if: (1) 80% of students in the classroom complete the test with minimum score is 70 from 100, and (2) users of teaching materials including teachers and students give positive responses with a percentage of more than equal to 80% (Aliyah et al., 2018).

RESULTS AND DISCUSSION

Based on the results that carried out at the analysis stage, the teacher stated that the teaching materials used were still using textbooks provided by the school, but other learning media on the internet were also used by teachers in distance learning during the pandemic, there were still some students who had not completed the daily test, and effective learning during the pandemic was discussion learning through video calls due to the lack of activeness of students in discussions if only using WhatsApp message media.

Teacher also stated that the expected skills from graduated students are independent, competitive, and creative in entrepreneurship. The factor that influence students to be creative in entrepreneurship is school must provide learning media that can support their students (Wikhdah et al., 2015). Meanwhile, students stated that the chemistry material could be understood easily, lesson was fun, and they prefer to study in groups. Students do not know and are not interested in the world of entrepreneurship, but they state that entrepreneurial people are creative people, so the research was conducted as introducing entrepreneurship in chemistry.

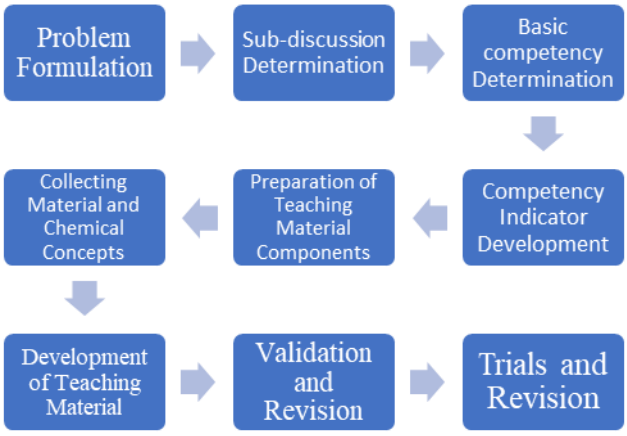
The results of observations found that students is passive in class when learning only done with WhatsApp messages, but students tend to be more active in class using teleconferencing media. So that the researcher concludes that the material can be maximized if it is delivered with the help of teleconferencing. The results of the literature review in the form of data on the results of test scores X MIPA 1 in the previous material showed in Table 1 also concluded that many students had not passed minimum, namely those with scores below 70.

Table 1 Data Results of Daily Test X MIPA 1 Previous Material

No	Subject	Score	Description	No	Subject	Score	Description
1	S-01	75	Pass	16	S-16	63	Not Pass
2	S-02	84	Pass	17	S-17	65	Not Pass
3	S-03	49	Not Pass	18	S-18	64	Not Pass
4	S-04	50	Not Pass	19	S-19	69	Not Pass
5	S-05	51	Not Pass	20	S-20	68	Not Pass
6	S-06	52	Not Pass	21	S-21	70	Pass
7	S-07	72	Pass	22	S-22	57	Not Pass
8	S-08	55	Not Pass	23	S-23	72	Pass
9	S-09	55	Not Pass	24	S-24	54	Not Pass
10	S-10	70	Pass	25	S-25	68	Not Pass
11	S-11	57	Not Pass	26	S-26	70	Pass
12	S-12	55	Not Pass	27	S-27	75	Pass
13	S-13	60	Not Pass	28	S-28	73	Pass
14	S-14	60	Not Pass	29	S-29	48	Not Pass
15	S-15	63	Not Pass	30	S-30	47	Not Pass

The data on the daily test scores of students in class X MIPA 1 is still low because there are only 9 out of 30 students passed minimum score. There needs a learning that has positive effect on students' understanding, one of which is the development of CEP chemistry learning aids (Afwa et al., 2018), because chemo-entrepreneurship can make entrepreneurial interest and affect to students performance (Ruliyanti et al., 2020).

The design stage is carried out in determining the research subject and making research flow diagrams. Material is redox and nomenclature of chemical compounds. Basic competencies were obtained from Ministry of Education and Culture (Kemendikbud, 2016). Indicators of competency achievement are developed from basic competencies and entrepreneurial. The flow chart developed of chemo-entrepreneurship-oriented teaching materials is shown in Picture 1.



Picture 1 Flow Chart

The development stage starts from making the design of teaching materials, making the design of supporting instruments, making the instrument validation sheet, the instrument validation stage, and the trial

stage. Making teaching material instruments starts from the preparation of teaching materials. The components of teaching materials used refer to the development of teaching materials by the Ministry of National Education and Arieska and Kamaludin, including title pages, introductions, table of contents, instructions for use, competencies, concept maps, core materials and chemo-entrepreneurship materials, assignments, and closing pages (Arieska & Kamaludin, 2018; Depdiknas, 2008).

Teaching material can be accessed by more devices through laptop and smartphone browsers, also can overcome distribution limitations. teaching materials. The application of electronic teaching materials in learning is one of the efforts to overcome the problem of limited printed teaching materials (Meek et al., 2016). The display of the developed teaching materials is presented in Picture 2a and the display when used is shown in Picture 2b.

Picture 2a. Teaching Materials

Picture 2b. Display of Teaching Materials When Used

The teaching materials that have been designed are then validated by three expert validators to assess the product before testing the product, so product is communicative (Lasmiyati & Harta, 2014). Aspects measured include material aspects, display aspects, aspects and chemo-entrepreneurship (Andrean et al., 2019). The higher validity means better conclusion (Hartini et al., 2018). The results of the validation carried out by three experts are presented in Table 2.

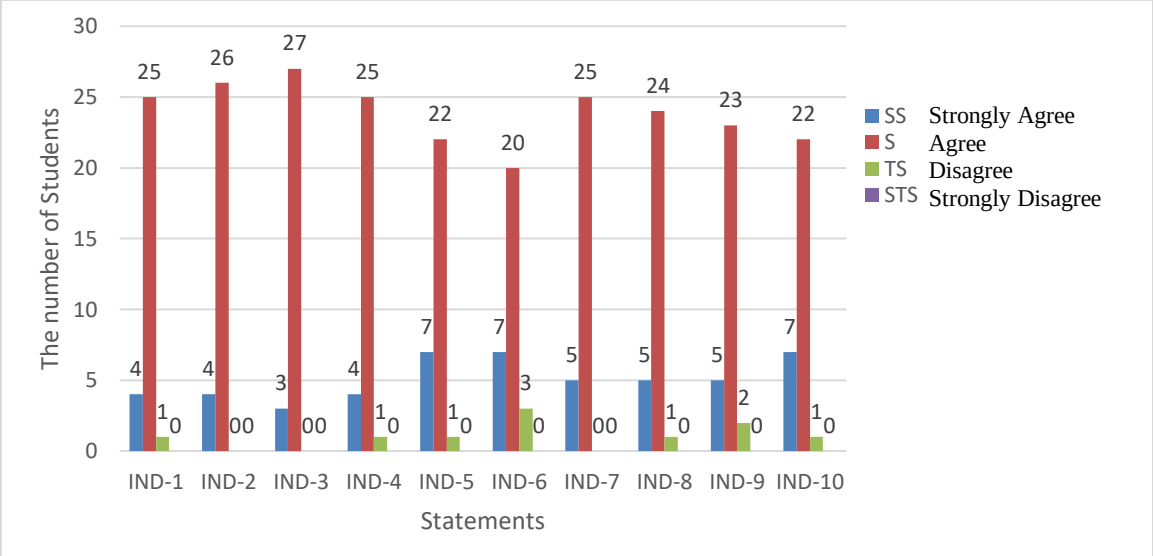
Table 2. Expert Validation Score of Teaching Material Instruments

Number	Validator Code	Total Score	Criteria
1	VT-1	49	Very valid
2	VT-2	50	Very valid
3	VT-3	48	Very valid

The teaching material instrument was declared to meet the very valid criteria by validator 1, validator 2, and validator 3. The teaching material instrument can be used for testing with an average score of 49 out of 52 which is included in the very valid criteria. The revisions to the teaching material instruments developed according to suggestions from expert validators include changes in the title page design, changes in the contents of the instructions for using teaching materials which are changed to be more descriptive and contain instructions for teachers as well as instructions for students, giving boxes as a differentiator between content sections with assignments, and adding practice questions to hone students' abilities.

Teaching materials that have gone through the validation and revision stages according to expert advice are then tested before the implementation stage. The trial was carried out in class XI MIPA 4 and the results obtained were in the form of input that must be improved again before the implementation stage. The input given

are about how easy to understand the developed materials, clarity and legibility of teaching materials, attractiveness of the design, attractiveness of delivering material, attractiveness entrepreneurial materials, attractiveness in making students creative entrepreneurship, contextuality, how is the project learning, how is students' interest in developing creative ideas, and relationship between entrepreneurship and chemistry. The results of the trial questionnaire are shown in Picture 3.



Picture 3. Results of Questionnaire Responses for Teaching Materials Test

The average response score for the trial phase was 31.36 from the maximum score of 40. The test got a percentage of 78.41% and was categorized in the "good" criteria. As for the input to the teaching materials developed at the trial stage, among others: pictures and examples are reproduced to make more interesting, add cartoon or animated illustrations so that they are more interesting to read and make students understand the topics being taught more quickly, multiply stories. inspirational about entrepreneurs to build students' creative ideas in entrepreneurship, adding animation and entertainment to make learning more interesting.

The implementation phase was carried out on 30 students of class X MIPA 1. The implementation phase using Google Meet. Students allowed to use chemo-entrepreneurship-oriented teaching materials that are developed outside of learning. The research activity was carried out for five meetings. The first to fourth meetings are used for learning activities and the fifth meetings used for daily test. Learning chemo entrepreneurship is carried out through project activities that produce entrepreneurial products (Sumarti et al., 2014).

Students in the implementation class were divided into 5 groups consisting of 6 students in each group, learning in groups can create interdisciplinary collaboration between students so that students can train collaboration such as scientists and product designers in making an efficient product (Bouldin & Wagner, 2019). The first assignment is to arrange problems that arise from or as a result of redox reactions, then students develop solutions to manufacturing product. Second assignment is to discuss solutions to stated problems on previous meeting. Students are directed to compile tools and materials and work steps to make entrepreneurial product. Third assignment is to make short video about making products from the projects being worked on. Videos of product making made by students are used to analyze the students entrepreneurial creativity. Students are active in learning in terms of activeness in answering questions and exercises given by the teacher. Students are confident in conveying their answers when asked to answer by teacher.

Entrepreneurial products developed by students are diverse. Products made by students include aromatherapy candles, banana nuggets, crispy apple donuts, and potato chips balado. The creativity of students is challenged through the manufacture of this product. Students look for materials and work steps for making products in groups through their respective references. Products made by students are presented in Table 3.

Table 3 Products made by students

No	Groups	Product	Picture
1	Group 1	Aromatherapy Candles	
2	Group 2	Banana Nuggets	
3	Group 3	Aromatherapy Candles	
4	Group 4	Apple Donuts	
5	Group 5	Potato Chips Balado	

Students are given daily test or evaluation at the end of the lesson to analyze abilities cognitive. The cognitive abilities of students after learning are measured by 15 questions multiple choice test. The results of the cognitive evaluation of the implementation class are presented in Table 4 and the recapitulation shown in Table 5.

Table 4. Results of Cognitive Evaluation Implementation Class

Subject	Score	Desc	Subject	Score	Desc
S-01	80	Pass	S-16	73	Pass
S-02	80	Pass	S-17	73	Pass
S-03	73	Pass	S-18	73	Pass
S-04	73	Pass	S-19	80	Pass
S-05	80	Pass	S-20	80	Pass
S-06	87	Pass	S-21	73	Pass
S-07	73	Pass	S-22	80	Pass
S-08	80	Pass	S-23	73	Pass
S-09	80	Pass	S-24	67	Not Pass
S-10	80	Pass	S-25	53	Not Pass
S-11	73	Pass	S-26	80	Pass
S-12	80	Pass	S-27	53	Not Pass
S-13	80	Pass	S-28	67	Not Pass
S-14	80	Pass	S-29	73	Pass
S-15	80	Pass	S-30	73	Pass

Table 5. Recapulation of Results

No	Criteria	Score
1	Highest score	87
2	Lowest score	53
3	Average score	75
4	Passed	26
5	Not passed	4
6	Total subject	30
7	Percentage	87%

The results of the analysis of cognitive tests is 87% of the total number of students in the class who completed the KKM with 26 students completing the total number of 30 students, it means this research is complete one of the goals like on the research by Aliyah (Aliyah et al., 2018). Most of the students have passed the minimum score and are able to understand, because teaching materials provides opportunity for student to better understand (Drastisianti et al., 2018).

The results of the teacher's response questionnaire are teaching materials suitable for use in chemo-entrepreneurship-oriented chemistry learning on redox material and nomenclature of chemical compounds. Teaching materials also have the potential to be developed on other materials by considering the contextuality of the material. Teaching materials get a score of 34 out of a maximum score of 40 with a percentage of 85% and are included in the "very good" category. The advice is to provide more entrepreneurial activities that can be practiced by students so they can be motivated and interested in trying entrepreneurship.

The results of students questuionnaire is developed teaching material suitable for use in chemistry learning. Recap of student responses to the developed teaching materials is presented in Table 6.

Table 6. Recap of student responses

No	Indicator	Total Score	Percentage (%)	Conclusion
1.	1	98	81,67	Very Good
2.	2	97	80,83	Very Good
3.	3	108	90,0	Very Good
4.	4	97	80,83	Very Good
5.	5	91	75,83	Good
6.	6	103	85,83	Very Good
7.	7	90	75,0	Good
8.	8	89	74,17	Good
9.	9	101	84,17	Very Good
10.	10	101	84,17	Very Good
11.	11	90	75,0	Good
12.	12	91	75,83	Good

Teaching material are easily understood by students. This is also influenced by the contextuality of the material so that it is easier for students to understand the material by finding redox events in everyday life. The design of the books presented is attractive and the orientation of entrepreneurial learning makes learning more interesting for students. Project learning helps students to come up with creative ideas and challenges students' creativity in preparing entrepreneurship-based chemistry projects (Dewi & Mashami, 2019; Hussain & Akhtar, 2013). Students claim to get additional benefits and insights gained from books and learning chemistry with a chemo-entrepreneurship orientation that was developed. Teaching materials obtained an average total score of 38.53 from a maximum score of 48 with a percentage of 80.28% and teaching materials were categorized in the "good" category, that's nearly reach previous research that developed teaching media based on chemo-entrepreneurship is ideal and good quality by 82% (Andrean et al., 2019).

CONCLUSION

Based on the research, we can conclude the developed teaching materials are suitable for uses in chemistry learning based on experts validation labelled "very good" category, responses of teachers is 85% labelled "very good" category, and responses from students are 80.28% labelled "good" category. Teaching materials also effective for analysing the cognitive abilities of students, the results is students have "high cognitive level" with 26 of 30 students complete minimum score or 87% in class and passed the classical completeness. While the average test score of students is 75, highest score obtained was 87 and the lowest was 53.

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