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Validation Miniature Hemodialysis Tools: STEM Project of Human Excretion Systems

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Abstract

The aim of this study was to validate the development of miniature hemodialysis tools for STEM projects in the learning of human excretion systems. The development of these miniature hemodialysis tools can help learners more easily understand the mechanism of dialysis in the study of human excretion systems. There are four aspects of assessing the validity of experimental tools; these aspects are relevance to the topic taught, ease, clarity and neatness, and size according to the learning environment. This assessment consists of four validation items that have 11 assessment indicators. Each assessment indicator has been scored as ≥ 3.00 by expert lecturers. This tool has been validated with an average assessment given by expert lecturer validators I, II and professional teachers, respectively, 3.46, 3.67, and 3.40. By averaging the ratings of the three validators, the validation score of this tool is 3.51. This means that all assessment criteria contained on the validation sheet have been met by the miniature hemodialysis tools.

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INTRODUCTION

Life in the 21st century demands various skills that a person must master, so it is hoped that education can prepare students to master these skills in order to become successful individuals in life. Briefly, 21st century learning has the main principle that learning must be student-centered, collaborative, contextual, and integrated with society (Zubaidah, 2016; Wijaya, 2016).

Continuous innovation is needed in education including in the learning process, so that it can help students in achieving the expected learning goals (Kadi & Awwaliyah, 2017; Safitri, 2022). Natural Science (IPA) is not only mastery in the form of facts, concepts, and principles, but also a systematic discovery process that students must take in solving problems (Wilujeng, 2018; Susilawati,2021).

The role of the teacher and the educational process are very important to develop students' potential and thinking abilities including critical thinking skills (Akinoglu and Baykin, 2015; Yennita et al., 2018). Teacher innovation and creativity are indispensable in presenting learning that can familiarize students with critical thinking. Such as adjusting learning to the material and conditions of students, so that activities in learning can be further improved and students' critical thinking skills can develop well (Agustia et al., 2019; Okolie,2022; Ramdani,2022).

STEM is a new approach to the development of the world of education that combines more than one discipline (Santoso and Mosik, 2019). According to Beers (2011), STEM learning is a combination of natural science with technology, engineering, and mathematics that is useful for improving 21st century skills. (Osman et al., 2013; Pfeiffer et al., 2013) mentioned that under STEM teaching sytem students use knowledge and skills integratedly. Students can link every dimension of STEM and this is a good indicator that students can metacognitively integrate all aspects of teaching, such as (1) science as knowledge about facts, concepts, rules, that should be understood; (2) technology as a skill used for organisation, knowledge, and articial tools for easying jobs; (3) engineerig as knowledge about design of procedure for solving problems; and (4) mathematics as knowledge about integration of numbers. All these knowledge will be meaningful when integrated.

Learning nowadays in line with the trend in globalization era, one of those is by integrating Science, Technology, Engineering, dan Mathematics (STEM). Relationship between sciences and technology or other knowledge can not be separated in sciences learning (Afriana,2016). To have a fun learning process in the classroom, an innovation is needed, one of the learning media used by teachers to support the learning process is teaching tools as a learning medium. The use of media helps students in understanding something abstract into something concrete (Yarlis,2020). The use of these tools will help make it easier for students to understand a concept (Afriyanto, 2015). STEM learning requires an active learning mode for students to apply STEM concepts through fun and challenging activities (Zaki,2020).

Learning tools are tools used to educate and deliver teaching materials, teaching materials such as objects or behaviors so as to make it easier for students to understand the lesson. (Preliana, 2015).

Learning tools contain characteristics and forms of teaching material concepts that are used to demonstrate material in the form of depictions of mechanization, events and activities so that the material can be more easily understood (Saleh et al., 2015). Learning tools are one of the success factors in the teaching and learning process. Another benefit of learning tools is one of the methods that can greatly stimulate students' interest in order to stay concentrated on the lesson. "Science lessons require a combination in the teaching and learning process using simple learning tools that are in accordance with children's intelligence, so the lessons are easy to understand"(Gunawan, 2019; Makransky, 2021).

Widiatmoko (2012) conveyed that the use of learning tools can involve the five senses of students who participate in using them through the activities of seeing, feeling, hearing, and using the mindset logically and systematically.

STEM approaches in learning can produce meaningful learning for students through the systematic integration of knowledge, concepts, skills and make students able to solve problems for the better. Students' STEM approach will have different ways of thinking and develop critical power and form a logic of thinking, so that it can be applied in various circumstances. In addition, the students will solve the problem well(Afriana, 2016). The development of miniature hemodialysis tools for STEM projects of human excretion systems prioritizes the use of science, technology, engineering and mathematics in these learning activities will investigate a problem, especially in the material of the human excretion system.

One of the materials in the science lesson that is expected to be quite good in developing students' critical thinking skills is the material of the Excretion System in Humans (Kurniahtunnisa, 2016).

Based on the problems that the researchers found, the researchers developed a miniature hemodialysis tool for the STEM project of the human excretion system. The purpose of this study was to develop a valid miniature hemodialysis tools for STEM project in human excretion systems learning.

METHOD

This research was conducted at the University of Riau. This research is a development research (Research and Development), which is carried out the development of miniature hemodialysis tools for STEM projects on human excretory system materials. Tools developed using ADDIE model stages (*Analyze, Design, Development, Implementation and Evaluation*) by Dick Walker and Lou Carey (2005). In this study, the ADDIE stage was carried out only at the Design and Development stage. The Design stage is the product design stage. This stage begins with making a tool design. The design is made first in the form of a sketch of the drawing, after which it is discussed with the supervisor perfecting the sketch design of the tool made as a learning tool. Figure 1 is the design of miniature hemodialysis tools.

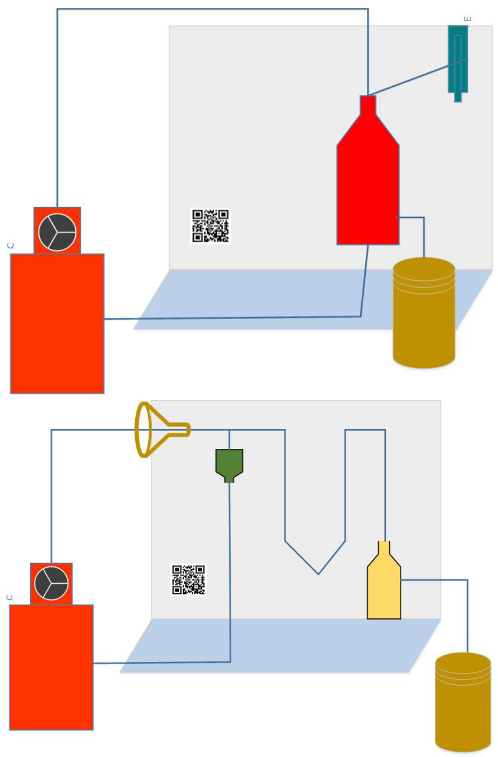

Figure 1. Design of miniature hemodialysis tools.

The development stage of Development is carried out by making tools then through validation by expert lecturers. The data obtained in this study is in the form of the validity value of the tool. The data collection instrument used is in the form of a tool validity sheet. A validity sheet is given to an expert to determine the degree of validity of the developed tool. Validator consisting of 2 lecturers and 1 professional teacher (a senior teacher who is experienced in teaching in class VIII). Thus producing a miniature hemodialysis tool for the STEM project of the human excretion system that is valid to be implemented. Validation sheet a miniature hemodialysis tool developed based on the elements contained in Table 1.

Table 1. Criteria for assessing the validity of learning tools.

Variabel	Source
Relevant with the topic taught	Asyhar (2012) dan Wahono (2006)
Ease	Asyhar (2012) dan Wahono (2006)
Systematic, coherent, clear logic flow	Asyhar (2012) dan Wahono (2006)
Size according to the learning environment	Asyhar (2012) dan Wahono (2006)

The validity test data are analyzed by looking at the scores given on each indicator and the average assessment of the overall validity of the tool by each expert. A learning media can be declared valid if each assessment indicator on the validity test sheet is worth ≥ 3. If there is an indicator that is worth < 3, it is necessary to make improvements or revisions to the media in accordance with the suggestions for improving the indicator.

Furthermore, the score of the validity criterion of the tool is calculated using the equation :

riteria score= (average scores)/(number of validators) (1)

Based on the formula, a value is obtained in the form of the level of validity of the tool. These values are then interpreted based on Table 2.

Table 2. Criteria for interpretation of validity assessments

Score	Levels Value	Category
	Very low	Not Valid
	Low	Not Valid

	Hight	Valid
	Very Hight	Valid

(Adapted from Riduwan, 2012)

Based on Table 2, if the criteria score obtained by the tool is < 2.50 then the device is declared invalid. Then on the contrary, the tool is valid if the criteria score obtained from the validity test results is 2.50 – 4.00.

RESULT AND DISCUSSION

This research developed a miniature hemodialysis device that has a function as a learning tool for students in order to understand the process of urine formation and dialysis carried out by people with kidney failure. At the design stage, tool design is carried out. The design of the tool is a sketch of a drawing made using the Microsoft Visio application.

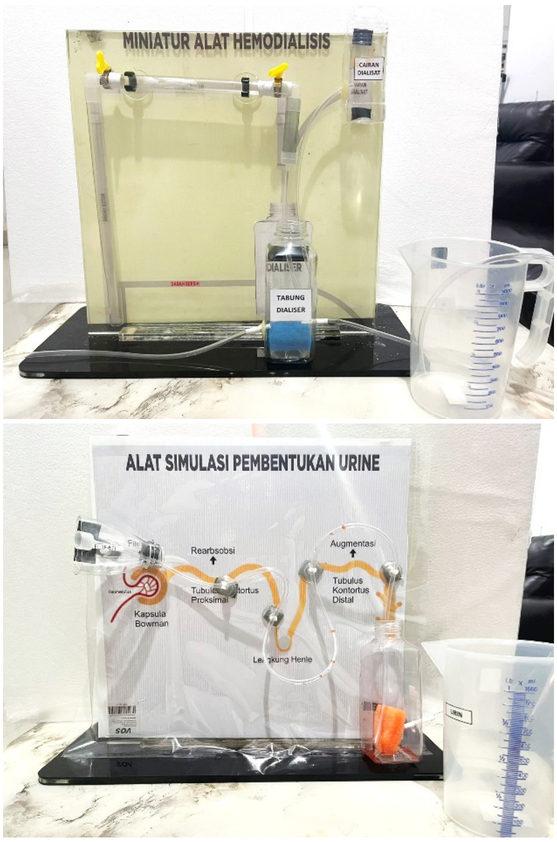

Figure 2. Miniature hemodialysis tools.

The miniature hemodialysis tool developed is a learning tool for making STEM projects in science learning human excretion system lessons. The advantage of this tool is that it can be used to carry out STEM projects simulating urine formation and hemodialysis mechanisms. There is STEM integration in this tool, in the scientific element there is knowledge about the process of urine formation, diseases of the kidney excretory organs, how to overcome the disease with dialysis and know the mechanism of hemodialysis. The technology element in the tool students can scan the barcode using a smartphone to be able to see the procedure for making the tool. The engineering element asks students to design a procedure for compiling miniature hemodialysis tools and building a project to make the tool. then the mathematics element makes students measure the volume of urine and hemodialysis residual substances produced from the experiment using tools.

The development stage is the development stage after the tool design is carried out. The finished tool is designed then continued at the manufacturing stage. The creation of the tool begins with making the tool outline part according to the design in Figure 2 is the appearance of the experiment tool that has been completed. In accordance with Asrori's research (2022) in the process of developing teaching tools, the tool's framework is an important aspect that needs to be prepared for smoothness in building the teaching tools.

The tool is made with the main materials are acrylic, transparent pipe, transparent hose and transparent bottle with output hole. The acrylic used by the side is 40 cm in size as a cross-section of the elements of the tool to be assembled. Acrylic was chosen as the material for the tool's production because acrylic was more transparent than other materials and was not easily broken (Astono,2020). The purpose of using transparent materials so that students can observe the process of blood flow in the work process of miniature hemodialysis tools. The materials used are a funnel from a bottle which is likened to a glomerulus, a transparent hose as a blood vessel through which blood will pass through which it will be excreted, a transparent pipe as a channel that connects the body with a hemodialysis device, a transparent bottle as a urine reservoir, a dialysate fluid tube and a dialyser tube. Then a measuring cup to measure the volume of urine and hemodialysis residual substances produced from the experiment using a tool.

The finished tool was created and tested for its usefulness and then assessed by the validator. The validation tool consisted of 3 validators. Validity assessment of miniature hemodialysis tools was carried out by assessing the validity of the tool based on demonstrations of the use of the tool. The results of the assessment of the validity of the tools were outlined in Table 3.

Table 3. The Validity Results

No	Validation Item	Validation Score			Average score
		V1	V2	V3	
1.	Relevant with the topic taught	3,50	3,50	3,25	3,42
2.	Ease	3,33	3,67	3,33	3,44
3.	Systematic, coherent, clear logic flow	3,00	3,50	3,00	3,17
4.	Size according to the learning environment	4,00	4,00	4,00	4,00
Average		3,46	3,67	3,40	3,51

There are 4 aspects of assessing the validity of the tool, namely relefan with the topic being taught, ease, clarity and neatness and the size used is in accordance with the learning environment. These four aspects refer to the assessment aspects by Arsyad (2011), Asyhar (2012) and Wahono (2006).

This assessment consists of 4 validation items that have 11 assessment indicators. Each of the assessment indicators has earned a score of ≥ 3. This tool has been declared valid with the average assessment given by validator I to validator III in a row is 3.46; 3.67 and 3.40. Overall, by averaging the assessments of the three validators, the validation score of this tool is worth 3.51. This means that the experiment tool has met all the assessment criteria contained on the validation sheet. Thus, then the miniature hemodialysis tools is valid.

There are suggestions for improvement provided by validators during the validation phase of this test tool. This repair is given by validator II, which is about leaks that occur in interconnected pipes, then leaks in the output holes of the dialyzed tube so that it is necessary to provide additional insulation on the pipe connectors and patches in the output holes of the dialyser tubes so that leaks do not occur.

There are difficulties found during this repair, the difficulty is the addition of insulation to the pipe with a connector, not enough, it is necessary to compress it with additional clamps so that no more leaks occur in the miniature hemodialysis tools. In line with research by Noer (2022), difficulties found in completing teaching tools became supports for easier-to-use teaching tool results. After improvements were made to the teaching tools based on suggestions from validators, the teaching tools became suitable for use and the results obtained were teaching tools that were easy and efficient to use. Good teaching tools are those that were easy to use and helped the learning process. (Noer, 2022; Nurdiansyah, 2021; Pramesty, 2013).

CONCLUSION

The research showed that the validation of the miniature integrated STEM hemodialysis tool on the human excretion system material received an average score of 3.51 from three evaluators. This indicates that the experimental tool met all the evaluation criteria on the validation sheet, hence it was considered valid. The developed teaching tool had the following features: (1) the simulation of hemodialysis was more realistic due to the presence of fluid movement using a water pump, (2) it demonstrated the formation of urine in the kidney nephron, (3) the main material used in creating the miniature STEM hemodialysis tool on the human excretion system was inexpensive, and (4) the tool was integrated with STEM. Furthermore, the miniature STEM hemodialysis project material on the human excretion system was deemed valid by three evaluators, which included two expert instructors and one biology teacher, making it appropriate for use as a learning tools.

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