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.

How to Cite
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 of facts, concepts, rules, that should be understood; (2) technology as a skill used for different ways of thinking and develop 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 system 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 (Kurniahtunni-
sa, 2016).

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

METHOD

This research was conducted at the Uni-
versity of Riau. This research is a development 
research (Research and Development), which is 
carried out the development of miniature hem-
dialysis tools for STEM projects on human excre-
tory system materials. Tools developed using AD-
DIE 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 De-
velopment 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.

The development stage of Development is 
 carried out by making tools then through valida-
tion 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 va-
lidity 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 excre-
tion system that is valid to be implemented. Valida-
tion sheet a miniature hemodialysis tool develo-
ded based on the elements contained in Table 1.

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

<table>
<thead>
<tr>
<th>Variabel</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relevant with the topic taught</td>
<td>Asyhar (2012) dan Wahono (2006)</td>
</tr>
<tr>
<td>Size according to the learning environment</td>
<td>Asyhar (2012) dan Wahono (2006)</td>
</tr>
</tbody>
</table>

The validity test data are analyzed by loo-
king 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 in-
dicator that is worth < 3, it is necessary to make 
 improvements or revisions to the media in accor-
dance with the suggestions for improving the in-
dicator.

Furthermore, the score of the validity criterion of 
the tool is calculated using the equation :
nriteria score= \( \frac{\text{average scores}}{\text{number of vali-
dators}} \) (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

<table>
<thead>
<tr>
<th>Score</th>
<th>Levels Value</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very low</td>
<td>Low</td>
<td>Not Valid</td>
</tr>
</tbody>
</table>
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.

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>
<thead>
<tr>
<th>Hight</th>
<th>Valid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Hight</td>
<td>Valid</td>
</tr>
</tbody>
</table>

(Adapted from Riduwan, 2012)
Table 3. The Validity Results

<table>
<thead>
<tr>
<th>No</th>
<th>Validation Item</th>
<th>Validation Score</th>
<th>Average score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>V1</td>
<td>V2</td>
</tr>
<tr>
<td>1.</td>
<td>Relevant with the topic taught</td>
<td>3.50</td>
<td>3.50</td>
</tr>
<tr>
<td>2.</td>
<td>Ease</td>
<td>3.33</td>
<td>3.67</td>
</tr>
<tr>
<td>3.</td>
<td>Systematic, coherent, clear logic flow</td>
<td>3.00</td>
<td>3.50</td>
</tr>
<tr>
<td>4.</td>
<td>Size according to the learning environment</td>
<td>4.00</td>
<td>4.00</td>
</tr>
</tbody>
</table>

There are 4 aspects of assessing the validity of the tool, namely relevant 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, 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.

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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REFERENCES


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