



How do Students Deal with Socio-scientific Issues: A Development of Students' Decision-Making Skills Instrument

Restu Utami^{1*}, Anti Kolonial Prodjosantoso¹, Eli Rohaeti¹, Azlan Kamari²

¹Department of Chemistry Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Indonesia.

² Faculty of Science & Mathematics, Universiti Pendidikan Sultan Idris, Malaysia.

* Corresponding author. E-mail: restuutami.2021@student.uny.ac.id

Abstract

Decision-making skills is needed in dealing with socio-scientific issues (SSI) that is developing in society. Students need to learn to make appropriate judgments, so that they were not easily manipulated or biased towards science-related issue. This paper aims to analyze the validity and reliability of the decision-making skills instrument. The research respondents were 75 high school students (female = 52, male = 23) at Bantul Regency, Special Region of Yogyakarta. The decision-making skills instrument consists of 5 items open-ended questionnaire. Respondents were determined using the random sampling method. The validity test results showed that all of 5 items developed were valid, with Pearson product moment values between 0.572 and 0.801. The reliability test results were valid for all 5 items, with a Cronbach's Alpha coefficient of 0.744. Therefore, it could be concluded that the instrument was valid and highly reliable to measure students' decision-making skills.

Keywords: decision-making, instrument, reliability, socio-scientific issues, validity

How to Cite: Utami, R., Prodjosantoso, A. K., Rohaeti, E., & Kamari, A. (2024). How do students deal with socio-scientific issues: A development of students' decision-making skills instrument. *Jurnal Pendidikan Matematika dan Sains, 12(1)*, 93-98, <http://doi.org/10.21831/jpms.v12i1.75002>

Permalink/DOI: DOI: <http://doi.org/10.21831/jpms.v12i1.75002>

INTRODUCTION

In dealing with socio-scientific issues (SSI) in society, students need to learn how to construct appropriate judgments. They should not be manipulated easily, or bias towards issues related to science (Leung, 2022). SSI-based learning provides a platform for developing scientific literacy skills, as well as socio-scientific reasoning skills which can lead to skills in understanding and responding to real-world problems (Cian, 2020). It was reported that the SSI concept mapping context design was able to increase knowledge content and also explain their science with argumentation (Su, 2021). Apart from that, SSI-based teaching can also help students make decisions regarding problems in society (Halim & Saat, 2017; Hsu & Lin, 2017).

Decision-making regarding SSI is a complex process that requires students to assess and consider the advantages and disadvantages of each argument, evaluate a variety of evidence to support the argument, consider between existing solutions, reveal conflicting interests held by stakeholders, and appropriately consider the

factors involved in the chemistry (Hsu & Lin, 2017; Meisert & Böttcher, 2019). Therefore, making decisions about SSI requires many skills and strategies that generally do not develop naturally (Hsu & Lin, 2017). Su (2021) used SSI Concept Mapping (SSICM) to conduct a better study guide for students in making decisions. Halim & Saat (2017) used the Persuasive Graphic Organizer (PGO) visualization tool to explore students' understanding when making decisions, while Hsu & Lin (2017) used an e-learning module to improve decision-making skills related to SSI.

In making a decision regarding an SSI-related issue, steps are needed to carry out the decision-making process. Dauer *et al.*, (2021) stated that in the decision making process includes steps such as defining the problem, evaluating criteria, identifying alternative options, collecting information for each option, analyzing options based on criteria, selecting options based on the analysis that has been carried out, then evaluating the decisions that have been taken. Meanwhile, Hsu & Lin (2017) stated that in decision-making processes includes

carried out such as compiling and detailing criteria (generating and elaborating criteria), analyzing alternative choices, making a decision, and evaluating decision-making results

The decision-making profile of Indonesian students has not been revealed in depth and the Instruments for exploring decision-making skills are still adapted from other sources (Ardwiyanti & Prasetyo, 2021). To develop instrument that can be used to measure students' decision-making skills that suitable in the context of SSI in Indonesia, it is necessary to develop a valid and reliable instrument. With the availability of this instrument, we can explore students' decision-making skills in the context of SSI in Indonesia.

METHOD

Participants

This study was conducted among 75 high school students (female = 52, male = 23) at Bantul Regency, Special Region of Yogyakarta, Indonesia. Determination of respondents using random sampling method.

Instruments

The decision-making skills instrument consists of 5 items of an open-ended questionnaire. Decision-making Skills aspects consist of: (1) Explain the effects of the problem (Halim & Saat, 2017), (2) Provide alternative solutions of the problems (Ardwiyanti & Prasetyo, 2021; Halim & Saat, 2017; Hsu & Lin, 2017; Sakamoto, Yamaguchi, E., Yamamoto, & Wakabayashi, 2021), (3) Analyze alternative solutions (Ardwiyanti & Prasetyo, 2021; Garrecht, Eckhardt, Höffler, & Harms, 2020; Sakamoto *et al.*, 2021), (4) Make a decision (Hsu & Lin, 2017), and (5) Evaluate the decisions that have been taken (Hsu & Lin, 2017).

Validity and Reliability

The Pearson product moment correlation (r) was used to evaluate the construct validity of each item to the total score. R equivalent with zero indicates no relationship between the variables, and $r = 1$ shows positive linear relationship between the variables (Puth, Neuhäuser, & Ruxton, 2014). The strength of correlation was determined by the Roemer-Orphal scale, where r between 0.0 and 0.1 considered as 'no correlation', when r ranged between 0.1 and 0.25 considered as 'very weak correlation', r between 0.25 and 0.40 as 'weak correlation', r between 0.40 and 0.50 as 'moderate correlation', r between 0.50 and 0.75

as 'strong correlation', r between 0.75 and 0.90 as 'very strong correlation', and as 'complete correlation' when r was between 0.90 and 1.00 (Câmpu & Ciubotaru, 2017; Petrovic D. Milun, 2012; Uzelac, Sladonja, Šola, Dudaš, Bilić, Famuyide, McGaw, Eloff, Mikulic-Petkovsek, & Poljuha, 2023). Cronbach's alpha was used to measure reliability of the decision-making instrument. Cronbach's alpha considered as a 'good' internal consistency if the total alpha value was more than 0.6 (Yusoff, 2011) and evaluated as 'high' when the Cronbach's alpha coefficient is 0.7 or more (Hussey, Alsalti, Bosco, Elson, & Arslan, 2020; Kılıç, 2022; Oh, Koh, Baek, Kwon, Jeung, Lee, Won, & Lee, 2019)

Students' Decision-making Skills

Students' answer to the decision-making instrument were summarized. The answers were scored from low-developed to high-developed (Ardwiyanti & Prasetyo, 2021). Each item was scored from 0 till 3 with a total score range of 0–15. The total scores were converted to 3 categories, where 0-5 indicates low-developed, 6-10 moderate-developed, and 11-15 high-developed.

RESULTS AND DISCUSSION

The Result of Validity Test

Students' decision-making skills are measured using 5 questionnaire items. The aspect of decision-making skills instruments is shown in the Table 1. The aspect aspects were synthesized from several sources. The 5 items are explain the effects of the problem (Halim & Saat, 2017), provide alternative solutions of the problems (Ardwiyanti & Prasetyo, 2021; Halim & Saat, 2017; Hsu & Lin, 2017; Sakamoto *et al.*, 2021), analyze alternative solutions (Ardwiyanti & Prasetyo, 2021; Garrecht *et al.*, 2020; Sakamoto *et al.*, 2021), make a decision (Hsu & Lin, 2017), and evaluate the decisions that have been taken (Hsu & Lin, 2017).

Based on the results of the validity test, it is known that all of the items are valid, with a value of $\alpha \leq 0.05$. The validity results are shown in Table 2. Furthermore, the strength of correlation could be determined by the value of Pearson correlation (r). As is shown in Table 2, the largest Pearson correlation is 0.801 from item number 3 (analyze alternative solutions) followed by item number 4 (make a decision) with 0.763 as the value of Pearson correlation. These two items categorize as 'very strong

correlation'. The remaining three, item number 1 (explain the effects of the problem), item number 2 (provide alternative solutions of the problems) and item number 5 (evaluate the decisions that

have been taken) categorize as 'strong correlation' with the values of Pearson correlation is 0.572, 0.697, and 0.701 respectively.

Table 1. Aspect of Decision-making Skills Instrument

Item	Aspect
Item 1	Explain the effects of the problem
Item 2	Provide alternative solutions of the problems
Item 3	Analyze alternative solutions
Item 4	Make a decision
Item 5	Evaluate the decisions that have been taken

Table 2. The Result of Validity Test

Item	Pearson correlation (r)	Sig. (2- tailed)	Validity	The strength of correlation
Item 1	0.572	0.000	Valid	Strong
Item 2	0.697	0.000	Valid	Strong
Item 3	0.801	0.000	Valid	Very Strong
Item 4	0.763	0.000	Valid	Very Strong
Item 5	0.701	0.000	Valid	Strong

Table 3. Reliability Statistics

Cronbach's Alpha	N of Items	Reliability
0.744	5	High

Table 4. Cronbach's Alpha Statistics

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Reliability
Item 1	7.03	7.080	0.313	0.773	Reliable
Item 2	7.19	6.721	0.524	0.695	Reliable
Item 3	7.04	6.093	0.665	0.643	Reliable
Item 4	6.99	5.797	0.561	0.679	Reliable
Item 5	7.23	6.637	0.521	0.695	Reliable

The Result of Reliability Test

The reliability test results show that the Cronbach's Alpha value of 0.744 from total 5 items as shown in Table 3. Cronbach's alpha of decision-making skills instrument considered as a 'high' reliable. Cronbach's Alpha from item 1, item 2, item 3, item 4, and item 5 are 0.773, 0.695, 0.643, 0.679, and 0.695 respectively as shown in Table 4. It was concluded that the instrument was reliable and can be referred to as an instrument that has a high level of consistency in measuring decision-making skills.

Discussion

In measuring instruments, validity and reliability tests are usually carried out. The validity test determines whether the instrument already compatible with the research objectives or not. Two types of validity that are generally accepted namely content validity and construct validity (Sürücü & Maslakçi, 2020). Construct validity or empiric validity test was carried out using product moment correlation. Pearson's product moment correlation, r, determined the strength of the linear relation between two variables. The values range from -1 to +1 (Michalos, 2014). The strength of correlation could be determined by the Roemer-Orphal scale, r between 0.50 and 0.75 considered as 'strong correlation', while r between 0.75 and 0.90

categorize as ‘very strong correlation (Câmpu & Ciubotaru, 2017; Petrovic D. Milun, 2012; Uzelac *et al.*, 2023)

Reliability is a test to consider if an experiment, test, or any measurement procedure have the same results on repeated tests (Kennedy, 2022). Cronbach's alpha was used to measure the consistency or reliability of the responses from the questionnaire (Bujang, Omar, & Baharum, 2018). Cronbach's alpha coefficient more than 0.6 was considered as a ‘good’ when the Cronbach's alpha coefficient is 0.7 or more considered as ‘high’ (Hussey *et al.*, 2020; Kılıç, 2022; Oh *et al.*, 2019)

The finding of the study indicates that the decision-making skills instrument is valid and reliable to determine students' decision-making skills. This can be seen from the correlation coefficient (r) of the Pearson product moment between 0.572 (min) that categorize as ‘strong correlation’ to 0.801 (max) that consider as ‘very strong correlation’ with a significant positive correlation ($p = 0.000$). The decision-making skills instrument is also considered as a ‘high’ reliable instrument with Cronbach's Alpha coefficient is 0.744.

Students' decision-making skills can be categorized as low-developed, moderate-developed, and high-developed skills. Students' decision-making skills differ in every aspect. For example the ability to propose an option was high-developed, while the ability to weigh the criteria was still low-developed (Ardwiyanti & Prasetyo, 2021). To enhance students' decision-making skills we could do several ways, namely intervention in the study (Sakamoto *et al.*, 2021) and implementation of SSI Concept Mapping (Su, 2021).

CONCLUSION

The results of the validity analysis showed that all 5 items are valid for measuring decision-making skills with Pearson product moment values between 0.572 and 0.801. From the reliability test of the 5 items of the decision-making skills instrument, the results showed that the instrument was reliable with a Cronbach's Alpha coefficient of 0.744. It can be concluded that instruments with strong correlation validity and high reliability can be used to measure students' decision-making skills.

REFERENCES

- Ardwiyanti, D., & Prasetyo, Z. K. (2021). Exploring students' decision-making ability in the context of socio-scientific issues. *Proceedings of the 6th International Seminar on Science Education (ISSE 2020)*, 541. <https://doi.org/10.2991/assehr.k.210326.096>
- Bujang, M. A., Omar, E. D., & Baharum, N. A. (2018). A review on sample size determination for cronbach's alpha test: A simple guide for researchers. *Malaysian Journal of Medical Sciences*, 25(6), 85–99. <https://doi.org/10.21315/mjms2018.25.6.9>
- Câmpu, V. R., & Ciubotaru, A. (2017). Time consumption and productivity in manual tree felling with a chainsaw – A case study of resinous stands from mountainous areas. *Silva Fennica*, 51(2). <https://doi.org/10.14214/sf.1657>
- Cian, H. (2020). The influence of context: comparing high school students' socioscientific reasoning by socioscientific topic. *International Journal of Science Education*, 42(9). <https://doi.org/10.1080/09500693.2020.1767316>
- Dauer, J. M., Sorensen, A. E., & Wilson, J. (2021). Students' civic engagement self-efficacy varies across socioscientific issues contexts. *Frontiers in Education*, 6. <https://doi.org/10.3389/educ.2021.628784>
- Garrecht, C., Eckhardt, M., Höffler, T. N., & Harms, U. (2020). Fostering students' socioscientific decision-making: exploring the effectiveness of an environmental science competition. *Disciplinary and Interdisciplinary Science Education Research*, 2(1). <https://doi.org/10.1186/s43031-020-00022-7>
- Halim, M., & Saat, R. M. (2017). Exploring students' understanding in making a decision on a socioscientific issue using a persuasive graphic organiser. *Journal of Baltic Science Education*, 16(5). <https://doi.org/10.33225/jbse/17.16.813>
- Hsu, Y. S., & Lin, S. S. (2017). Prompting students to make socioscientific decisions: embedding metacognitive guidance in an e-learning environment. *International Journal of Science Education*, 39(7).

- <https://doi.org/10.1080/09500693.2017.1312036>
- Hussey, I., Alsalti, T., Bosco, F., Elson, M., & Arslan, R. (2020). An aberrant abundance of Cronbach's alpha values at .70. *PsyArXiv*. 10.31234/osf.io/dm8xn
- Kennedy, I. (2022). Sample size determination in test-retest and cronbach alpha reliability estimates. *British Journal of Contemporary Education*, 2(1), 17–29. <https://doi.org/10.52589/bjce-fy266hk9>
- Kılıç, F. (2022). The relationship among entrepreneurship tendency, income level and life satisfaction of future business people: Generation z. *International Business Research*, 15(3), 1. <https://doi.org/10.5539/ibr.v15n3p1>
- Leung, J. S. C. (2022). Shifting the teaching beliefs of preservice science teachers about socioscientific issues in a teacher education course. *International Journal of Science and Mathematics Education*, 20(4). <https://doi.org/10.1007/s10763-021-10177-y>
- Meisert, A., & Böttcher, F. (2019). Towards a discourse-based understanding of sustainability education and decision making. *Sustainability (Switzerland)*, 11(21). <https://doi.org/10.3390/su11215902>
- Michalos, A. C. (2014). Pearson product moment correlation. In *Encyclopedia of Quality of Life and Well-Being Research* (pp. 4670–4670). Springer Netherlands. https://doi.org/10.1007/978-94-007-0753-5_102956
- Oh, S. Y., Koh, S. J., Baek, J. Y., Kwon, K. A., Jeung, H. C., Lee, K. H., Won, Y. W., & Lee, H. J. (2019). Validity and reliability of korean version of simplified nutritional appetite questionnaire in patients with advanced cancer: A multicenter, longitudinal study Original Article. *Cancer Research and Treatment*, 51(4). <https://doi.org/10.4143/CRT.2018.505>
- Petrovic D. Milun. (2012). Correlation analysis of milk production traits across three generations of Simmental cows. *African Journal Of Biotechnology*, 4(47). <https://doi.org/10.5897/ajb11.1634>
- Puth, M. T., Neuhäuser, M., & Ruxton, G. D. (2014). Effective use of Pearson's product-moment correlation coefficient. In *Animal Behaviour* (Vol. 93). <https://doi.org/10.1016/j.anbehav.2014.05.003>
- Sakamoto, M., Yamaguchi, E., Yamamoto, T., & Wakabayashi, K. (2021). An intervention study on students' decision-making towards consensus building on socio-scientific issues. *International Journal of Science Education*, 43(12). <https://doi.org/10.1080/09500693.2021.1947541>
- Su, K. D. (2021). Implementation of SSI Concept Mapping as a Dynamic Learning Environment to Enhance Students' Scientific Performance. *Journal of Baltic Science Education*, 20(6). <https://doi.org/10.33225/JBSE/21.20.969>
- Sürücü, L., & Maslakçi, A. (2020). Validity and reliability in quantitative research. *Business & Management Studies: An International Journal*, 8(3), 2694–2726. <https://doi.org/10.15295/bmij.v8i3.1540>
- Uzelac, M., Sladonja, B., Šola, I., Dudaš, S., Bilić, J., Famuyide, I. M., McGaw, L. J., Eloff, J. N., Mikulic-Petkovsek, M., & Poljuha, D. (2023). Invasive alien species as a potential source of phytopharmaceuticals: phenolic composition and antimicrobial and cytotoxic activity of Robinia Pseudoacacia L. leaf and flower extracts. *Plants*, 12(14). <https://doi.org/10.3390/plants12142715>
- Yusoff, M. S. B. (2011). Reliability & validity of the adult learning inventory among medical students. *Education in Medicine Journal*, 3(1). <https://doi.org/10.5959/eimj.3.1.2011.or3>

PROFILE

Restu Utami

A Master's degree holder from Department of Chemistry Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Indonesia. She received a Master degree of Chemistry Education in 2021.

Anti Kolonial Prodjosantoso

A lecturer from Department of Chemistry Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Indonesia. Expertise in Inorganic Chemistry. In 2001, he received his PhD in Inorganic Chemistry from University of Sydney, Australia.

Eli Rohaeti

A lecturer from Department of Chemistry Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Indonesia. Expertise in Polymer Chemistry and Chemistry Education. She earned a Doctorate in Chemistry in 2004 from Institut Teknologi Bandung, Indonesia.

Azlan Kamari

A lecturer from the Faculty Of Science And Mathematics, Universiti Pendidikan Sultan Idris (UPSI), Tanjung Malim, Perak, Malaysia. Specializes in Analytical Chemistry. He obtained a Doctorate in Chemistry in 2011 from University of Glasgow, Scotland, UK.