

# Indonesian Bebras Challenge 2021 Exploratory Data Analysis

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**Abstract.** Indonesia is a full member of International Bebras Community and regularly perform the annual Bebras Challenge since 2016. The tasks for the Indonesian Bebras Challenge are taken and adapted from International Bebras Task pool, and each of the tasks is related to informatics and Computational Thinking (CT). We explore and analyze the Indonesian Bebras Challenge 2021 data to find interesting insight into Indonesian student’s competencies in informatics and computational thinking, the suitability of the selected Bebras Tasks difficulty level for each age group, and the relation between participants’ score and time duration in completing Bebras Challenge. The data exploratory has been done with statistics and data visualizations. We found that Indonesian students need to learn more about informatics and CT. The difficulty level of the Indonesian Bebras Challenge for elementary school students is still in accordance with Indonesian students’ competency. In contrast, the Bebras Challenge difficulty level for junior and senior high school is higher than the students’ competency. By analyzing the time duration of each participant completing the challenge, we also found some dishonest attitude presumptions during the online Bebras Challenge. We discover some suggestions for the improvement of Indonesian Bebras Challenge event as a means to improve Indonesian students’ informatics and CT skills.

**Keywords:** Bebras Challenge, Bebras task, Exploratory data analysis.

## 1. Introduction

The Indonesian Ministry of Education, Culture, Research, and Technology (MoECRT) launched “Kurikulum Merdeka” (Independent Curriculum) as one of the curricula that are available in elementary, junior, and senior high schools in Indonesia (Direktorat Jendral PAUD Dikdas dan Dikmen, 2022). Before the implementation of Kurikulum Merdeka, informatics was an elective subject, and Computational Thinking (CT) is unrecognized in most of Indonesian education. In Kurikulum Merdeka, informatics has become a compulsory subject in junior and senior high school. For the elementary school, CT has integrated into Mathematics, Indonesian, Natural and Social Sciences subjects. CT has become a fundamental part of the informatics subject for junior and senior high school (MoECRT, 2021).

One of the challenges in Indonesian education is the inequality of education quality and IT facilities between big cities and remote areas (MoECRT, 2022). Indonesian students didn't get good results on the PISA Test (OECD, 2019). However, Indonesia still has excellent students who regularly participate in international Olympiads of various subjects, including Olympiads in Informatics (IOI), and got some achievements (IOI, 2023). Liem (2016) was said that although there is a gap in the quality of education between remote areas and big cities in Indonesia, it is hoped that the selection process for IOI will remain balanced between "potential candidates" from remote areas and "ready to compete" candidates from big cities.

Bebras Community is an international initiative that aims to promote informatics and computational thinking among students and teachers of all ages. One of the activities of Bebras community is organizing an annual contest called Bebras Challenge. Bebras task, the name of each question in Bebras Challenge, involves informatics and/or computational thinking concepts and must be possible to be answered without prior knowledge of informatics (Dagienė and Stupurienė, 2015).

Indonesia has been participating in organizing Bebras Challenge since 2016. The number of Indonesian Bebras Challenge participants in 2016–2021 is shown in Fig. 1.

The growing number of Indonesian Bebras Challenge participants in 2016–2021 (Bebras.org, 2011b) shows that Bebras is getting increasingly known in Indonesian education. Bebras Challenge become a good potential means to improve the informatics and CT skills of Indonesian students. Since Bebras Task can be answered without using a computer, it is suitable to be used to improve informatics skills for Indonesian students in remote areas with limited computer facilities.

Exploratory Data Analysis (EDA) is the act of looking at the data from many angles lookout for some interesting features. In short, EDA is looking at the data to see what it seems to say (Morgenthaler, 2009). Our data features are task code, task title, difficulty level, age group, CT and informatics concept, a unique identifier for each participant, time spent for each participant to complete the challenge, the score for each task, and the total scores of each participant.

Based on the fact about the challenges in Indonesian education, the potential that Indonesian students have, the new position of informatics subject and CT in Kurikulum



Fig. 1. Indonesian Bebras Challenge Participants Number.

Merdeka, and the growing number of Indonesian Bebras Challenge participants, the objectives of this Indonesian Bebras Challenge 2021 Exploratory Data Analysis (2021-ID-EDA) is exploring and finding interesting insights from Indonesian Bebras Challenge 2021 data. The EDA insights we discover are related to:

1. **(RQ1)** How appropriate is the difficulty level for each age group for students in Indonesia?
2. **(RQ2)** What is the general description of the informatics abilities of Indonesian students based on the results of the 2021 Bebras Challenge? Is there any specific kind of informatics or CT skill that need more attention for students in Indonesia?
3. **(RQ3)** Is there any interesting information about the participants' time competing in the Indonesian Bebras Challenge 2021? Is there any interesting relationship between the time spent on Bebras Challenge and the participants' grades? Are there any unreasonable data in the relation between spent time and participants' grades in the contest?

We hope that the result represents Indonesian students in the informatics and CT field.

The paper is organized as follows: Section 1 describes the introduction of this work, and in Section 2, we describe the literature review and we describe Indonesian Bebras Challenge 2021 characteristics in Section 3. In Section 4, we describe our EDA process. In Section 5, we report the 2021-ID-EDA results. Last, in the Section 6, we draw some conclusions and suggestions and describe our future works.

## **2. Literature Review**

Bebras is an international initiative whose goal is to promote informatics and computational thinking, especially among teachers and students of all ages, but also to the public at large (Dagienė and Stupurienė, 2015). Currently, 55 countries join as full-member of Bebras International and 22 countries as provisional-member of Bebras (Bebras.org, 2023). Each country that joins Bebras is led by National Bebras Organization (NBO), that responsible for Bebras' activities within its country, such as creating and submitting Bebras Task, teacher training, organizing Bebras Challenge, selecting and translating Bebras Task so that the task become suitable for their country's Bebras Challenge (Dagienė and Stupurienė, 2016).

Bebras Challenge is a contest for elementary, junior, and senior high school pupils organized by International Bebras Community (IBC) and NBO in each country. The challenge is held on the second week of November, declared as worldwide Bebras Week. The main goal of Bebras Challenge is to motivate and encourage pupils to learn informatics fundamentals (concepts) and to support the development of algorithmic thinking and Computational Thinking. There are five age group recommendations from IBC, that are Little Beavers (grades 3–4), Benjamin (grades 5–6), Cadet (grades 7–8), Junior (grades 9–10), and Senior (grades 11–12). Each age group has its own question set.

Bebras task is a short question that involves fundamental informatics concepts and is answerable through the computerized interface. The criteria of Bebras task are solvable in 3 minutes, presentable on a single screen page, and independent from a specific system. Each task is equipped with recommendations about age group preferences and a difficulty level for each age group.

Some previous studies have analyzed Bebras Task and Bebras Challenge results. Bebras Challenge's result is significant to be analyzed because each country has a different standard of education. Bebras Task difficulty level needs to be assessed to ensure that the participants do not perceive it as appealing because it is too easy or too difficult (Bellettini, *et al.*, 2015). In (Bellettini, *et al.*, 2015), the difficulty level of the Bebras Challenge for Italian students has been analyzed using Item Response Theory (IRT). They found that 30% of the selected tasks were too easy or too difficult than the question preparation team expected. The results of this research can be used as input for the team compiling their questions in making adjustments for the next Bebras Challenge.

Izu, Mirolo, Settle, & Mannila (2017) analyzed the role of the CT concept in determining the difficulty level of questions, students' performance between schools in seven countries (Italy, Australia, Finland, Lithuania, South Africa, Switzerland, and Canada), and how gender differences affect scores. One part of their research was determining the CT concept that each Bebras Task addressed. Their research concludes that there are no significant differences in the CT skills of students from different schools. The CT concept does not determine the difficulty level of the questions. Differences in abilities for different genders are relative to age. At senior age, boys outperform girls in all countries.

### 3. Indonesian Bebras Challenge 2021

Even though Bebras Challenge is an international event, each country organizes its own Bebras Challenge. Bebras NBO can independently determine the age group of the pupils, select Bebras Tasks from the internationally accepted Bebras task pool, translate the task (Dagienė and Stupurienė, 2016), adjust the task's context based on the local situation, and determine the tools for their Bebras Challenge.

As we are in the pandemic situation, Indonesian Bebras Challenge 2021 was held fully online, and could be done at school or at home under the supervision of teachers. In multiple choice tasks, the participant gets plus points for the correct answer, 0 for the unanswered tasks, and negative points for wrong answers. While for short answer tasks, there is no penalty point for the wrong answer. Due to the limitation of Indonesian Contest Management System, Indonesia does not offer interactive task.

Indonesian Bebras Challenge is organized into four age groups. The name of the age category is inspired by the Indonesian scouting organization: Siaga (Cub Scout), Penggalang (Scouts), and Penegak (Rover Scouts). The youngest age group is named SiKecil (the small one). The age group, number of given tasks, and duration of the challenge are shown in Table 1.

Table 1  
Indonesian Bebras Challenge Age Group

Age group name's / category	Student's age	Number of tasks	Duration of the challenge (minutes)
SiKecil	Up to 3 <sup>rd</sup> grade	8	30
Siaga	4 <sup>th</sup> –6 <sup>th</sup> grade	12	40
Penggalang	7 <sup>th</sup> –9 <sup>th</sup> grade	15	45
Penegak	10 <sup>th</sup> –12 <sup>th</sup> grade	15	25

Table 2  
Number of Participants of Indonesian Bebras Challenge 2021

Age group name's / category	Number of Indonesian participants	Number of English participants	Total
siKecil	3.604	308	3.912
Siaga	5.800	348	6.148
Penggalang	9.558	582	10.140
Penegak	6.297	377	6.674
<b>Total</b>	<b>25.259</b>	<b>1.615</b>	<b>26.847</b>

The tasks selected for each age group are based on Bebras International age group and difficulty level preference. Each age group has a combination of task difficulty levels: easy, medium, and hard.

Since 2020, the Indonesian Bebras Challenge has been given in Indonesian or English. The English option has been offered as requested by some schools that adopt the international curriculum, primarily the school in big cities, where many of their students are interested in continuing their studies abroad. The number of participants for each category and language is shown in Table 2.

#### 4. Exploratory Data Analysis Process

The 2021-ID-EDA process given in Fig. 2 is described below:

1. Data collection. The data are collected from two sources: (step 1) the Indonesian Bebras Challenge 2021 result and (step 2) the information related to each Bebras Task feature. Indonesian Bebras Challenge result was taken from the Bebras Challenge website with the permission of the Bebras Indonesia NBO. 33 files need to be combined before the data analysis process. The data features are a unique identifier for each participant, start time, end time, duration of the challenge, total score, and score for each task number.

The features of each Bebras Task are task code, task title, difficulty level, age group, and informatics concept. Those features are simply taken from the International Bebras Taks Workshop recommendation contained in the header

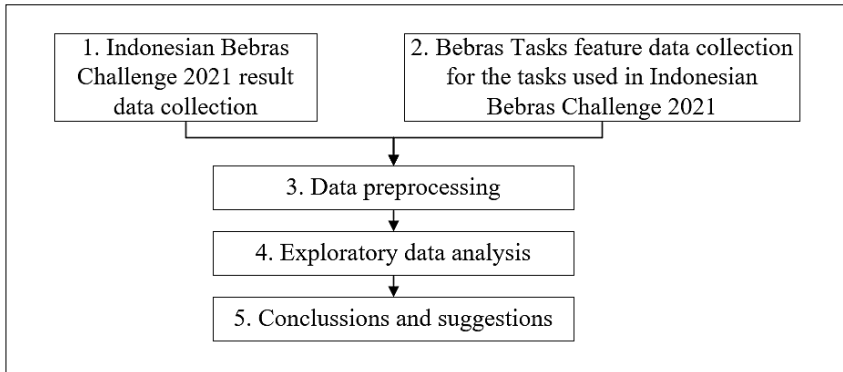


Fig. 2. Data Exploratory and Analysis Process.

of each task. We extracted other task features: question/task type and CT concepts involved in each task and the task language. We extracted manually CT concepts that were addressed in each task with a similar process that was done in (Izu, Mirolo, Settle, & Mannila, 2017).

2. Data preprocessing (step 3). The first step of data preprocessing is to combine the data from each age group category. There are three or four separate files for each age group (Table 1): the result of English participants, the result of Indonesian participants, and the make-up challenge for a specific language. We add a language column to the data.

For each task, there is a value that defines the score of that specific task for each participant. The maximum score is  $100/(\text{number of tasks in a specific age group category})$ . The minimum value is 0 for short answer questions and a negative point for the multiple-choice wrong answer. We do the data normalization by changing the score value with an integer 1 for the correct answer, -1 for the wrong answer, or 0 for the unanswered task. The normalization aims to categorize the participants' answers and calculate the percentage of each category.

3. The 4<sup>th</sup> and 5<sup>th</sup> steps are described in Sections 5 and 6.

The tool we used for this EDA is R Studio.

## 5. Exploratory Data Analysis

We did two points of view data exploration and analysis:

1. Score distribution for each task (Section 5.1). This exploration aims to answer RQ1 and RQ2.
  - a. To answer RQ1, we explore the mean, the standard deviation of participants' scores in each age group, and the success rate for each Bebras Task.

b. RQ2 is related to (Dagienė and Stupurienė, 2016) that the tasks should attract students and drive them to learn and explore to develop skills in a particular area. The exploration of each Bebras Task success rate can be analyzed for answering RQ2 as well.

3. Time spent completing Bebras Challenge (Section 5.2). This exploration aims to answer RQ3.

The threat of validity of this EDA is the data taken from all Indonesian Bebras Challenge 2021 participants. Due to the uneven education facilities and infrastructures (MoECRT, 2022) that may affect education quality in some areas of Indonesia, we could say that we use uncontrolled data.

### 5.1. Exploration and Analysis of Score Distribution for Each Age Group and Each Bebras Task Used in Indonesian Bebras Challenge 2021

The score distribution for each age group is shown in Fig. 3. Based on Fig. 3, we can see that the achieved score is lower in the older age group. Fig. 4 shows the score distribution for each age group and each Bebras Task language. There is no significant difference in score distribution between each task language. This finding is the first identification of no significant task language translation problem. However, the translation result will be analyzed further by each task analysis in Sections 5.1.1–5.1.4.

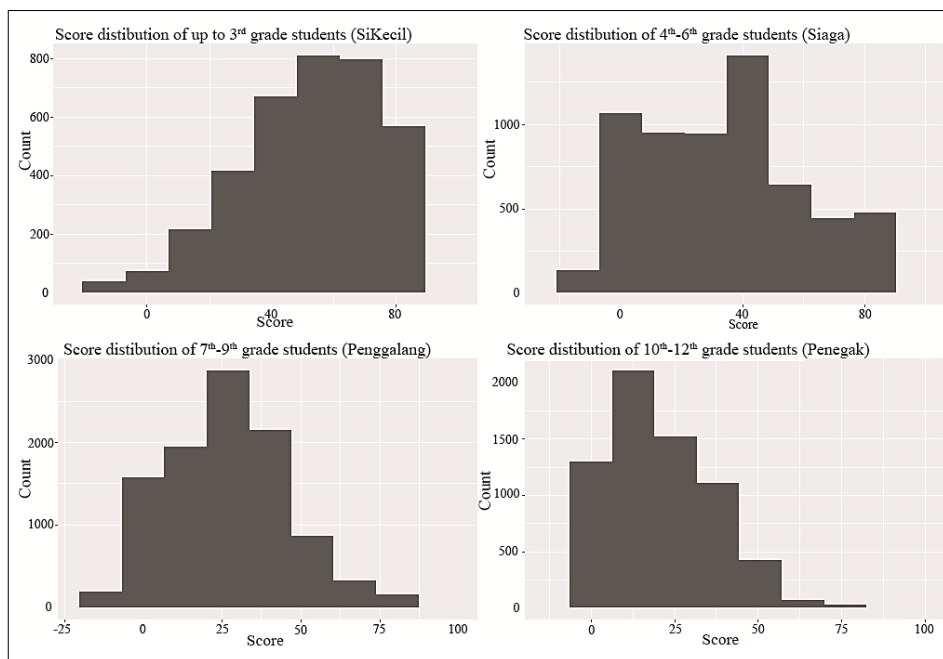


Fig. 3. Score Distribution for Each Age Group in Indonesian Bebras Challenge 2021.

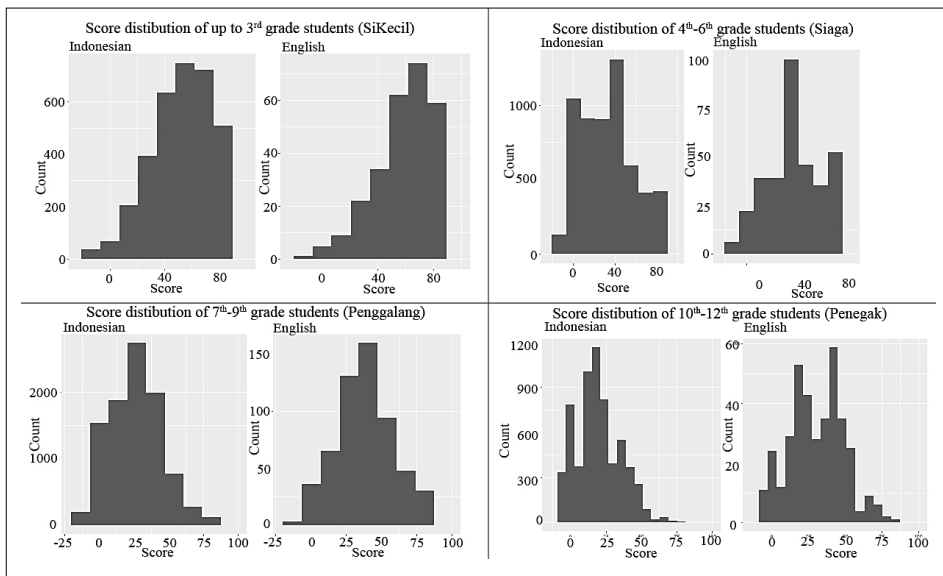


Fig. 4. Score Distribution in Indonesian Bebras Challenge 2021 for Each Age Group and Each Task Language.

The statistic of the Indonesian Bebras Challenge 2021 result is shown in Table 3. The maximum score for each participant is 100.




The statistics in Table 3 show that the mean score of English participants is higher than that of Indonesian participants and the mean scores are getting lower in the older age groups. There is no significant difference between the English and the Indonesian standard deviation. It means that score dispersions for both languages are similar. The

Table 3  
Statistics of Indonesian Bebras Challenge 2021

Age Category and Statistic Components	Language	
	Indonesian	English
Up to 3 <sup>rd</sup> grade students (SiKecil)		
Score mean	55,66	63,64
Score standard deviation	26,78	25,65
4 <sup>th</sup> –6 <sup>th</sup> grade students (Siaga)		
Score mean	33,95	46,24
Score standard deviation	26,35	26,39
7 <sup>th</sup> –9 <sup>th</sup> grade students (Penggalang)		
Score mean	25,44	39,37
Score standard deviation	19,46	22,09
10 <sup>th</sup> –12 <sup>th</sup> grade students (Penegak)		
Score mean	19,39	30,48
Score standard deviation	15,90	18,63



Table 4  
Bebras Task Answer Category for Fig. 5–Fig. 8

Category number	Category color	Meaning
1	 blue	Correct answer
0	 green	Blank
-1	 pink	Wrong answer

Indonesian translation for Bebras Task tends to be difficult because some common terms in English, especially informatics terms, do not have the Indonesian standard word translation. Thus, sometimes the sentences in Indonesian Bebras Task are longer than in English, so the students need more time to read the task.

In Sections 5.1.1–5.1.4, Indonesian students' performance is analyzed by their success rate in answering each Bebras Task. The success rate describes the students' ability to answer each task correctly. The answer category of each Bebras Task is displayed in different colors and category numbers, described in Table 4.

Each task answer category distribution is analyzed with the information about the task: difficulty level for each age group recommendation, task type, informatics concepts, and CT concepts. Here are the abbreviations used in each Indonesian Bebras Task 2021 description:

- a. Difficulty level: Hard (H), Medium (M), Easy (E).
- b. Task type: Multiple choices (MC) and Short answer (SA).
- c. Informatics concepts: Algorithms and programming (AP); Data, data structures, and representations (DSR); Interactions, systems, and society (ISC); Computer processes and hardware (CH); Communication and networking (CN).
- d. CT concepts: Abstraction (A); Algorithmic thinking (AT); Decomposition (D); Evaluation (E); Pattern recognition (P).
- e. Language: English (en); Indonesian (id).

#### 5.1.1. *Students up to 3<sup>rd</sup> Grade Age Group Performance (Category: SiKecil)*

The Indonesian Bebras Challenge 2021 answer category distribution for the SiKecil Category for each language is shown in Fig. 5.

The color and category explanation for Fig. 5 is given in Table 4. Based on Fig. 5, the success rate of Indonesian and English participants in task number 8 differs quite a lot. The success rate of Indonesian and English are 44,9% and 24%, respectively. Thus, the difference is 20%. This information can be a reason for reviewing the Indonesian task translation.

To review the suitability of the international difficulty level suggestion of the Bebras Task and the competency of the SiKecil age group, we analyze each task's success rate. The Bebras task list for the SiKecil category is given in Table 5. The grey rows in Table 5

refer to tasks with a success rate of less than 50%. It means more than half of the students cannot answer the task correctly.

Based on Fig. 5 and Table 5, the students didn't perform well in Bebras Tasks number 2, 6, and 8, which have a hard difficulty level. The worst students' performance was on task number 8, which has a hard difficulty level and task type as short answer question. The characteristics of CT concepts on tasks 2, 6, and 8 combine algorithmic thinking and another concept. The tasks that have an easy and medium difficulty level can be answered correctly by most Indonesian participants. The difficulty level for the SiKecil category is generally suitable for Indonesian students.

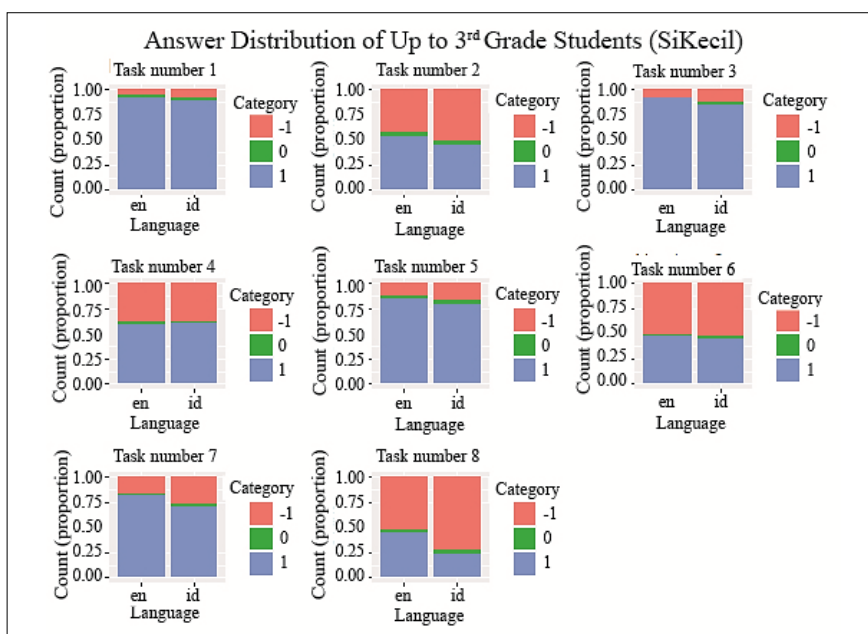


Fig. 5. Answer Distribution for up to 3<sup>rd</sup> Grade Students (SiKecil).

Table 5  
Bebras Task List for up to 3<sup>rd</sup> Grade Students (SiKecil)

Number	Task Code	Task Title	Success rate	Difficulty Level	Task Type	Informatics Concepts	CT Concepts
1	2021-CN-01	The Lost Gold	89,34%	M	MC	DSR	AT
2	2021-CN-06a	Forgetful Little Beaver	46,37%	H	MC	AP	AT, E
3	2021-IE-05	Dancing Dress	85,69%	E	MC	AP, DSR	E
4	2021-LT-06	Do They Meet	59,94%	H	MC	AP	AT
5	2021-PK-09a	Creatures	80,44%	E	MC	AP, DSR	E, D
6	2021-SA-02	Flower Growth Phase	44,86%	H	MC	AP	AT, A
7	2021-UY-01	Circular Beaver	72,11%	M	MC	DSR	A
8	2021-UY-06	Fruit Road	25,72%	H	SA	DSR	AT, E

5.1.2. 4<sup>th</sup>–6<sup>th</sup> Grade Age Group Students' Performance (Category: Siaga)

The color and category explanation for Fig. 6 is given in Table 4. Based on Fig. 6, task number 3, 4, 5, and 9 have success rates that differ quite a lot between English and Indonesian participants. The success rates are:

- a. Task number 9: Indonesian: 34,6%; English: 77,2%; difference: 42,6%.
- b. Task number 5: Indonesian: 34,6%; English: 71,8%; difference: 37,2%.
- c. Task number 3: Indonesian: 45,3%; English: 64%; difference: 18,7%.
- d. Task number 4: Indonesian: 40,3%; English: 56%; difference: 15,7%.

The differences in the success rates can be a suggestion to review the task translation or context for Indonesian students.

The suitability between the international difficulty level suggestion of the Bebras Task and the competency of the Siaga category participants has been made in the same way as the SiKecil age group. The grey rows in Table 6 have the same meaning as in Table 5.

The retrieved information from Fig. 6 and Table 6 are:

- a. The lowest participants' success rate is at task number 1 (2021-CA-01, Cuckoo Birds), which has a hard difficulty level. The Indonesian and English success rates are 23,6% and 34,7%, respectively.
- b. The highest participants' success rate is task number 10 (2021-PK-09, Creatures), which has an easy difficulty level. The Indonesian and English success rates are 69,5% and 55,1%, respectively.

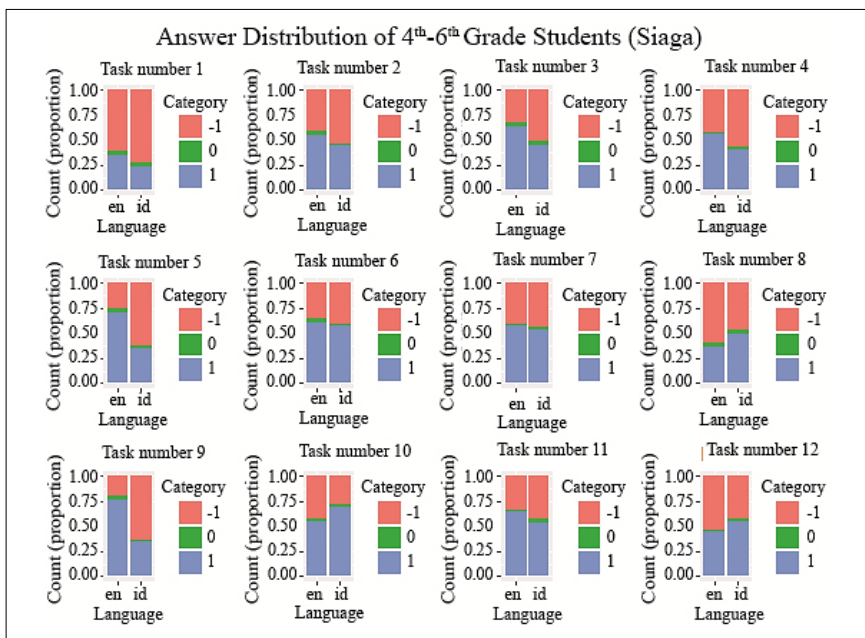


Fig. 6. Answer Distribution for 4<sup>th</sup>–6<sup>th</sup> Grade Students (Siaga).

Table 6  
Bebras Task List for 4<sup>th</sup>–6<sup>th</sup> Grade Students (Siaga)

Number	Task Code	Task Title	Success Rate	Difficulty Level	Task Type	Informatics Concepts	CT Concepts
1	2021-CA-01b	Cuckoo Birds	24,32%	H	MC	DSR	E
2	2021-CN-03a	Picking Up Carrots	44,65%	M	MC	AP, DSR	AT, E
3	2021-CN-06	Forgetful Little Beaver	46,39%	H	MC	AP	AT, E
4	2021-IE-01	Presents Program	41,20%	H	MC	AP	A, E, AT
5	2021-IE-02	Coin Bag	36,73%	M	MC	DSR	A, D
6	2021-KR-01	Gujeolpan	57,03%	M	MC	DSR	P, E
7	2021-KR-02	Moving the Balls	52,80%	M	MC	AP, DSR	AT
8	2021-LT-06	Do they Meet	49,41%	M	MC	AP	AT
9	2021-LT-07	Find a Mistake	37,09%	M	MC	AP	AT, E
10	2021-PK-09	Creatures	68,69%	E	MC	AP, DSR	E, D
11	2021-RO-02	Volcanos	54,68%	H	MC	CN	AT, E
12	2021-UY-01	Circular Beaver	54,21%	E	MC	DSR	A

- c. 7 of 12 tasks got success rates less than 50%.
- d. More than 50% of participants can correctly answer both easy tasks.
- e. 2 of 6 medium tasks can be correctly answered by more than 50% of participants.
- f. 1 of 4 hard tasks can be correctly answered by more than 50% of participants.
- g. Five tasks combining Algorithmic Thinking and Evaluation CT concepts (tasks no. 2, 3, 4, 9, 11). The success rates for four of them are less than 50%.

Based on points a to f, the difficulty level of the twelve Bebras tasks in the Siaga category is still in accordance with the competence of Indonesian students.

### 5.1.3. 7<sup>th</sup>–9<sup>th</sup> Grade Age Group Students' Performance (Category: *Penggalang*)

The color and category explanation for Fig. 7 is given in Table 4. Based on Fig. 7, the success rates of Indonesian and English participants differ quite a lot on task number 5 and 6. The differences are:

- a. Task number 5: Indonesian: 46,7%; English: 68,3%; difference: 21,6%.
- b. Task number 6: Indonesian: 42,2%; English: 60,6%; difference: 18,4%.

The differences in the task's success rate may have two meanings, the quality of the students is different or can be a suggestion to improve the task translation or context for Indonesian students.

The grey rows in Table 7 have the same meaning as in Table 5. The retrieved information from Fig. 7 and Table 7 are:

- a. 12 of 15 tasks cannot be correctly answered by more than 50% of participants in the *Penggalang* category.
- b. 2 of 3 easy tasks can be answered correctly by more than 50% of participants in the *Penggalang* category. The easy task difficulty level is still in accordance with *Penggalang* category participants.

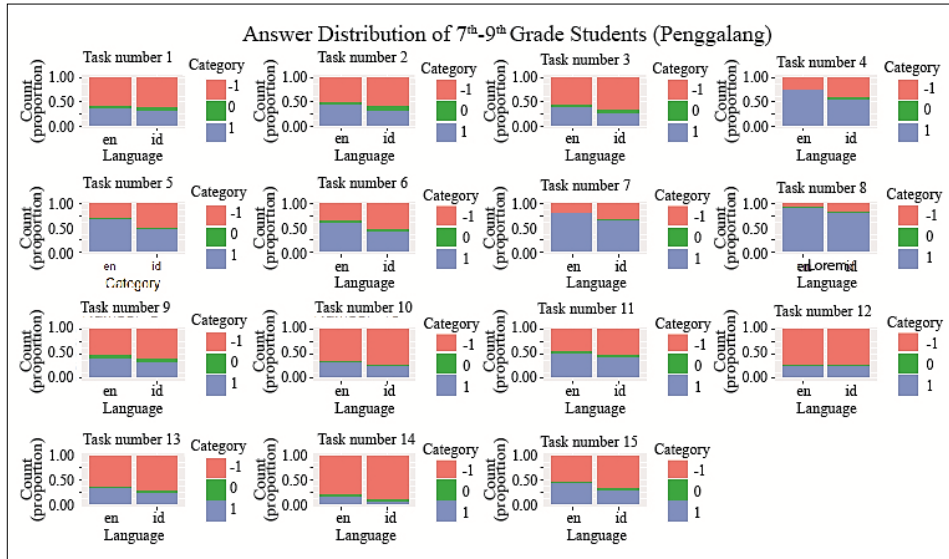


Fig. 7. Answer Distribution for 7th–9th Grade Students (Penggalang).

Table 7  
Bebras Task List for 7<sup>th</sup>–9<sup>th</sup> Grade Students (Penggalang)

Number	Task Code	Task Title	Success Rate	Difficulty Level	Task Type	Informatics Concepts	CT Concepts
1	2021-BE-03	Necklace Instruction	31,70%	M	MC	AP, DSR	A, P
2	2021-CA-02	Spider Quilt	31,95%	H	MC	DSR	AT, D
3	2021-CA-04	Line of Fish	26,58%	M	MC	AP, DSR	AT, E
4	2021-CH-04c2	Strawberry Thief	55,64%	E	MC	AP, DSR	A, E
5	2021-CN-02	Maze	47,99%	E	MC	AP	AT
6	2021-DE-07	Turtle Path	43,26%	M	MC	AP	A, AT
7	2021-ID-10	Density of Liquid	64,42%	M	MC	DSR	E, AT
8	2021-IS-04a	Between Dots	80,33%	E	MC	AP, DSR	AT
9	2021-IT-1b	Strange Sorting	31,83%	H	MC	AP, DSR	E, AT
10	2021-LT-01	Meeting race	23,78%	H	MC	AP, ISC	AT
11	2021-LT-05	Compare	43,19%	H	MC	AP	AT, E
12	2021-NZ-01	Hidden Chocolate	23,28%	H	MC	AP	AT, E, D
13	2021-UZ-02	Pruning the Tree	24,47%	M	MC	AP, DSR	AT, D
14	2021- LT-03	Three Beavers	5,93%	M	SA	AP, CH	A, AT
15	2021-AT-01	Forest Observation	28,81%	M	SA	AP	A, AT

- c. The lowest participants’ success rate is task number 14 (2021-LT-03, Three Beavers). The task type is a short answer question. It needs an integer as the input, so there is a low possibility of a wrong formatting answer or typo.
- d. The participants’ success rates for short answer tasks (2021-LT-03 and 2021-AT-01) are meager.

- e. Due to the low success rate in general, the CT and Informatics concepts analysis cannot be done.

Based on points a to e, the performance of the Penggalang category participants is lower than the expectation of the International Bebras Committee, which is stated in each task difficulty level.

#### 5.1.4. 10<sup>th</sup>–12<sup>th</sup> Grade Students' Performance (Category: Penegak)

The color and category explanation for Fig. 8 is given in Table 4. Based on Fig. 8, five tasks cannot be answered correctly by most of the participants. The participants' success rates are:

- Task number 12: Indonesian: 11,70%; English: 3,18%; in general: 1,29%.
- Task number 14: Indonesian: 3,03%; English: 7,16%; in general: 3,26%.
- Task number 11: Indonesian: 3,76%; English: 8,48%; in general: 4,03%.
- Task number 13: Indonesian: 10,60%; English: 22,01%; in general: 11,32%.
- Task number 10: Indonesian: 11,95%; English: 26,79%; in general: 12,79%.

Task 15 is the task that has the most difference in English and Indonesian success rates. The success rate for Indonesian participants is 42,57% and for English participants is 63,12%; thus, the difference is 20,55%.

The grey rows in Table 8 have the same meaning as in Table 5.

The retrieved information from Fig. 8 and Table 8 are:

- 13 of 15 tasks cannot be correctly answered by more than 50% of participants in the Penegak category.
- The participant's success rate for tasks number 1 and 8 are also under 60%.
- 4 of 5 tasks with the lowest success rate are short answer questions.

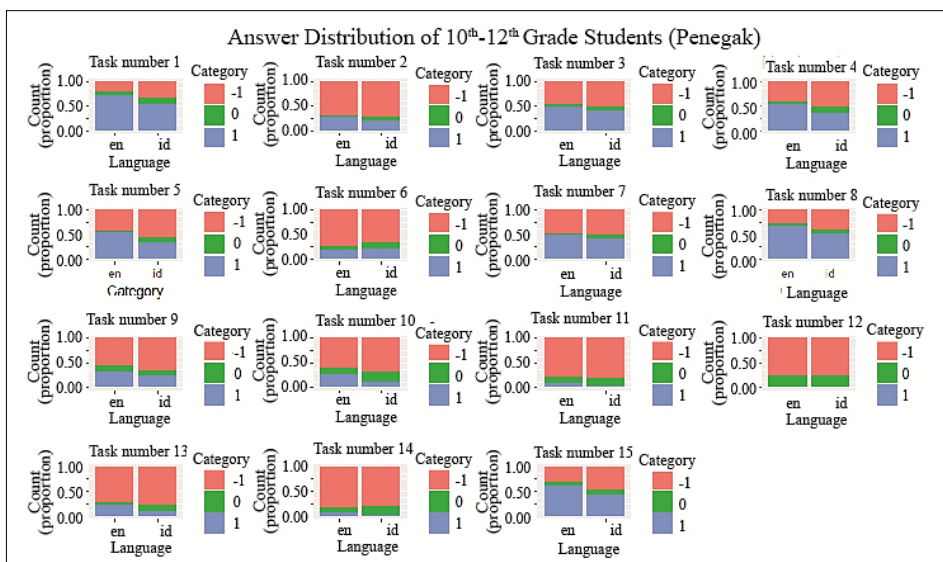


Fig. 8. Answer Distribution for 10th–12th Grade Students (Penegak).

Table 8  
Bebras Task List for 10<sup>th</sup>–12<sup>th</sup> Grade Students (Penegak)

Number	Task Code	Task Title	Success Rate	Difficulty Level	Task Type	Informatics Concepts	CT Concepts
1	2021-AT-04d	Hashing	55,38%	M	MC	AP, DSR	AT
2	2021-BE-02	Vaccination Center	21,56%	M	MC	AP, DSR	E, AT
3	2021-CH-26b	Chez Connie	41,95%	E	MC	CH	AT
4	2021-NZ-02	Ice Cream Machine	36,20%	H	MC	CH	AT, E, D
5	2021-PT-05	Flooding	36,86%	E	MC	AP, DSR	A, AT
6	2021-RU-01	Save the Trees	21,82%	M	MC	AP, DSR	AT, E
7	2021-SK-02	Lift	43,66%	E	MC	DSR	D, A
8	2021-SP-01	Ordering 7 Students	53,27%	M	MC	AP	AT
9	2021-TW-03b	Napping Together	24,60%	E	MC	DSR	AT, A
10	2021-DE-04	Lawn Mover	12,80%	E	SA	AP, DSR, ISC	AT
11	2021-EE-03	Logs	4,03%	M	SA	AP, CN	AT, P, A
12	2021-IT-05	Snow White	1,29%	M	MC	AP	AT, E
13	2021-LT-01	Meeting Race	11,33%	M	SA	AP, ISC	AT
14	2021-PH-03	Great Wall of Beavaria	3,27%	M	SA	AP	AT
15	2021-CH-06	Compact Representation	43,74%	H	SA	DSR	AT

- d. All the easy tasks get a success rate under 50%.
- e. As in the Penegak category, the CT and Informatics concepts analysis cannot be done due to the low participants' success rate in general.

Based on points a to e, the performance of the Penegak category participants is lower than the expectation of the International Bebras Committee, which is stated in each task difficulty level.

### 5.2. Exploration and Analysis of Time Spent Completing Indonesian Bebras Challenge 2021

The purposes of the analysis of time spent completing the Indonesian Bebras Challenge 2021 are to know the majority of the time needed by Indonesian Bebras Challenge participants in completing the challenge and identify whether there is unreasonable data found during the challenge. We assume that the unreasonable data of time spent behavior is when the participant got a high score in less than the given duration for each age group category. The assumption was taken because we assume it is very difficult for the student to solve each task in one and a half minutes since they need time to read and understand the problem before thinking about its solution. We realize that this assumption may not be true for a very clever student.

Fig. 9 shows the time distribution for each Indonesian Bebras Challenge age group participant to complete the challenge. The graphic shows that the older the age group is, the longer time needed to finish the challenge. There are some outliers in Penggalang and Penegak categories.

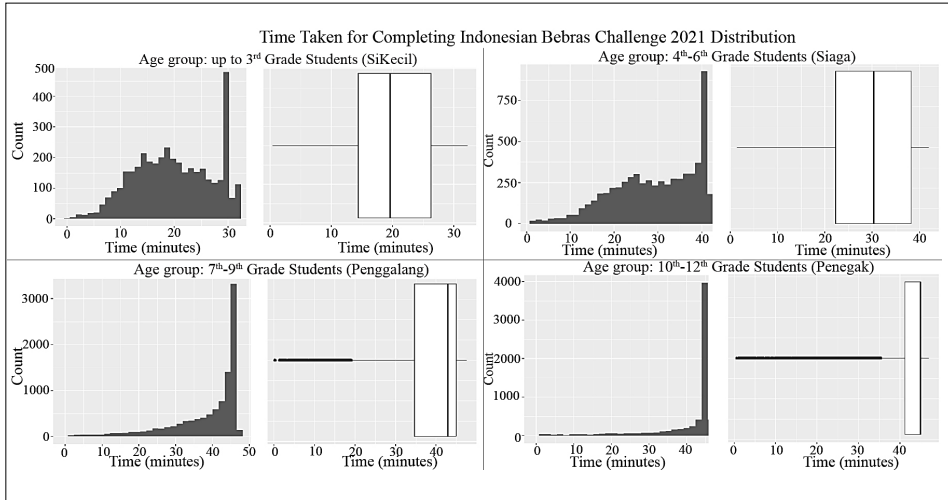


Fig. 9. Time Taken for Completing Indonesian Bebras Challenge 2021 Distribution for Each Age Group.

To gain more information, we explore the relationship between the time taken to complete Indonesian Bebras Challenge 2021 and the participant's scores for each age group. The plot results are shown in Fig. 10. There are two unreasonable data based on Fig. 10:

- i. The blue boxes in Fig. 10, show the scores from participants who completed the challenge in more than the given duration. It was confirmed to the Indonesian Bebras Challenge 2021 organizing committee that those were the consequences of the server's queue due to the auto-submit system when the challenge's time was up.
- ii. The red boxes in Fig. 10 show the mapping between participants who got high scores in less than half of the given challenge duration for each age group. These unreasonable data indicate the possibility that some participants behaved dishonestly during the challenge.

Fig. 10 shows that some participants finished the challenge in a short time. We looked closer and made the plots to observe whether the low participants' scores resulted from the perfunctory participants. We assume that the perfunctory participants were guessing the answer without thinking carefully to get the correct answer. The plot is shown in Fig. 11.

We took data from 25% of the participants who got the lowest score in each age group and drew the chart of their time taken in finishing the challenge in Fig. 11. Those graphics show that most participants with low scores still worked for over half the duration. Some of them finished the challenge within the maximum given duration. This information may lead to the conclusion that not all participants with low scores are perfunctory. They still gave their effort until the time was up.



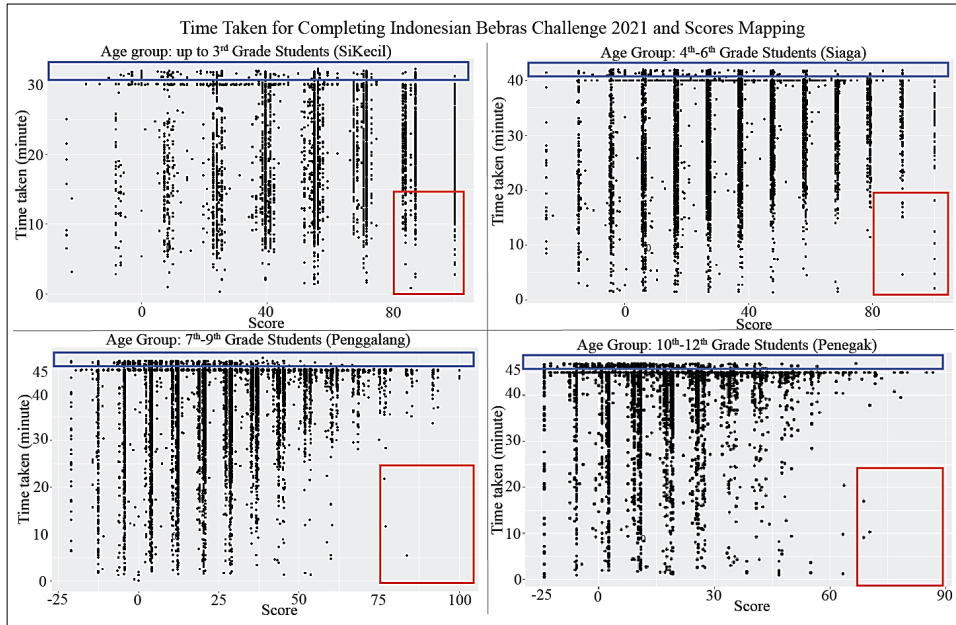


Fig. 10. Time Taken for Completing Indonesian Bebras Challenge 2021 and Scores Mapping.

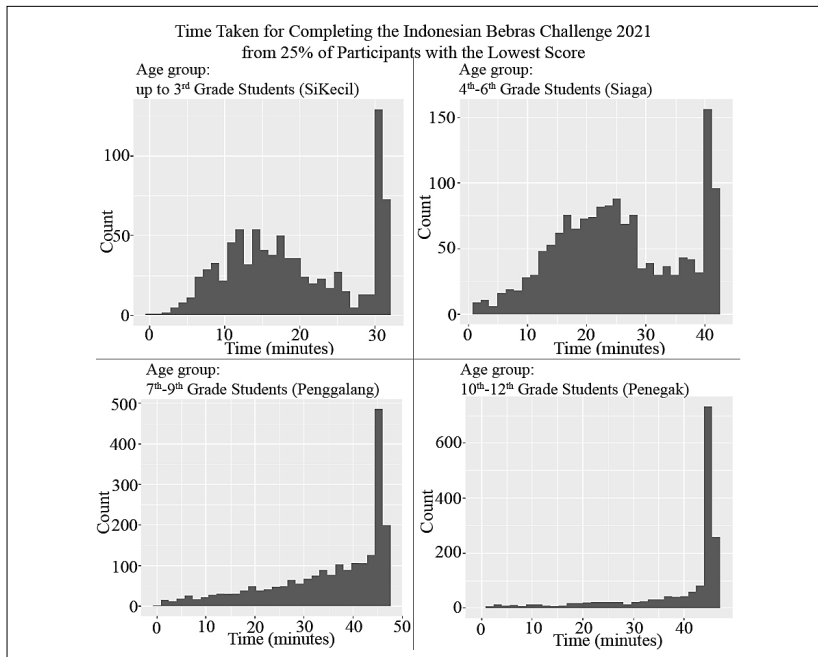


Fig. 11. Time Taken for Completing the Indonesian Bebras Challenge 2021 from 25% of Participants with the Lowest Score.

### 5.3. The Result of Indonesian Bebras Challenge 2021 EDA

The result of the Indonesian Bebras Challenge 2021 EDA is given by answering each EDA question (**RQ1–RQ3**).

1. **Respond to RQ1.** Based on Fig. 5–Fig. 8 and Table 5–Table 8, the difficulty levels of selected Bebras Tasks for SiKecil and Siaga categories are still in accordance with Indonesian students' competence. Due to the many questions that cannot be answered correctly by more than 50% of participants, it can be concluded that the difficulty level of Bebras Tasks in Penggalang and Penegak categories as stated by the international Bebras Task Committee are higher than the Indonesian participants' competence.

In general, the participants of SiKecil (up to 3<sup>rd</sup>-grade students) and Siaga (4<sup>th</sup>–6<sup>th</sup>-grade students) categories perform quite well in the Bebras Challenge. The participants of Penggalang (7<sup>th</sup>–9<sup>th</sup> grade students) and Penegak (10<sup>th</sup>–12<sup>th</sup> grade students) categories did not perform well enough. The score mean of each age group given in Table 3 shows that the younger age group is higher than the older age group.

2. **Respond to RQ2.** In general, Indonesian students' informatics competency still needs improvement. Based on Table 5, the informatics concepts in selected Bebras Tasks for the SiKecil category are not varied enough to be the base of informatics skill analysis. The participants of the SiKecil category need more exercise on the task that involves an Algorithmic Thinking concept combined with another concept. Based on Table 6, Table 7, and Table 8, the analysis of participants' informatics and CT skills cannot be done due to the low success rate in many tasks.
3. **Respond to RQ3.** Based on Fig. 9, it can be concluded that the higher the challenge category was, the longer time needed to complete the challenge. Many participants finished the challenge in the maximum given time in Penggalang and Penegak categories. We also found two unreasonable data based on the plot of the relation between the time needed to complete the challenge and the participants' score as shown and described in Fig. 10. Some dishonest attitude presumptions during the online Bebras Challenge event can be caught in Fig. 10: some participants got high scores in a short completion time.

The suggestion for the next Indonesian Bebras Challenge events based on this EDA are:

- a. The method in selecting Bebras Task for each age group in the Indonesian Bebras Challenge must be discussed in the Indonesian Bebras Challenge task preparation team, especially for Penggalang and Penegak categories which have low success rates in many tasks. Bebras Task difficulty level needs to be assessed to ensure that the participants do not perceive it as appealing because it is too easy or difficult (Belletini, *et al.*, 2015). The task preparation teams need to adjust the difficulty level of each age group as suggested by the International Bebras Task Workshop

since Indonesia still has low PISA Test scores compared to other countries that join PISA Test, that shows, in general, the Indonesian students' performance is lower than many other countries. The fact that Informatics and CT are new in Indonesian education curriculum may affect the Indonesian students' performance in Indonesian Bebras Challenge.

- b. The Indonesian Bebras Challenge preparation teams may ask teacher review for the Indonesian tasks translation so that the translation is appropriate for each age group.
- c. The Indonesian Bebras Challenge preparation teams need to adjust the rules or the system related to the online Bebras Challenge event. The monitoring system of the online event needs to be evaluated to minimize the dishonesty that happened in Indonesian Bebras Challenge. Indonesian Bebras NBO needs to work with the teacher to encourage the students to work independently.

## **6. Conclusion**

The 2021-ID-EDA questions (RQ1–RQ3) has been answered by the EDA result. By exploring the data related to Indonesian students' performance in Indonesian Bebras Challenge 2021 and the evaluation of Bebras tasks difficulty level for each age group, we found that the task difficulty level for the elementary students age group is still in accordance with the Indonesian student's competencies. But the junior and senior high school students did not perform well in the Indonesian Bebras Challenge 2021. The difficulty level of selected Bebras Tasks for Penggalang and Penegak categories is higher than the students' competencies. The unreasonable data was found by analyzing the relation between the time for completing the challenge and the participants' scores that led to a presumption of students' dishonest attitude in the online Bebras Challenge event. The older the age group, the longer time needed for the students to finish the challenge. In general, Indonesian students still need a lot of work to increase their skills in informatics and CT.

We also discover three suggestions for the Indonesian Bebras Challenge preparation team to improve the Indonesian Bebras Challenge event. The suggestions are about (1) the selection of Bebras Task difficulty level for each age group, (2) the improvement of Indonesian task translation, and (3) the evaluation of the monitoring system of the online Indonesian Bebras Challenge event. We hope that the results of 2021-ID-EDA can make the Bebras challenge implemented better in Indonesia so that Indonesian students can practice and increase their knowledge in informatics and CT.

Our future work will analyze the Indonesian Bebras Tasks translation used in SiKecil and Siaga (up to 6<sup>th</sup>-grade students) categories. There is some feedback from the teachers and parents that their child cannot understand some terms used in the tasks. This research will be done together with elementary school teachers.

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