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Figure 3 shows a planing machine. An ingenious driving mechanism causes the backward and forward movement of the planing tool holder.

The machine is only planing when the holder is moving to the left: the planing move. No planing takes place when the holder is moving back (to the right): the back move.

In figure 4 you see the driving mechanism.

A lever is connected to a crank disk by means of a crank pin and a movable block. The lever is also connected to the planing tool holder by means of a movable block. Through this construction, the rotational movement of the crank disk is transformed in the back- and forward movement of the holder.

The picture on the right in figure 4 shows the position of the lever at the beginning of the planing move. The crank disk moves at a constant speed.

 14 Use figure 4 to explain why the planing move lasts longer than the back move.
The movement of the planing tool holder can be described with a \( d-t \) formula. Figure 5 shows a schematic picture of the driving mechanism. This picture can be helpful for finding the formula.

\[
d(t) = \frac{r \cos(\omega t)}{0.5r \sin(\omega t)}
\]

6p  □ 15 Explain how this formula can be found, using figure 5.

For the length of the crank pin and for the rotational speed of the disk fixed values are chosen:
\( r = 0.25 \text{ m} \) and \( \omega = 2 \text{ rad/s} \)

For these fixed values, the graph of \( d(t) \) on the GC looks like

On worksheet 3, you find several copies of this graph. You may use these copies when answering the following questions.

4p  □ 16 Find the measure of angle \( \alpha \) (accurate to degrees) at the beginning of the planing move.

This driving mechanism has a very nice quality: the speed is almost constant during the planing move.

2p  □ 17 How can this be concluded?

4p  □ 18 Find the speed of the holder, halfway the planing move.

4p  □ 19 For which angle \( \alpha \) (between 0 and \( 2\pi \)) has the holder its maximum speed?

4p  □ 20 Find the maximum speed

Solution:
The cran disk turns around at a constant speed. The drawing shows how during the planing move a greater number of radians is covered which means this move takes more time.

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**6 score points**

Figure 3 shows two similar triangles. The ratio of the lengths of the sides connected to the right angle is equal. This leads to:

\[
\frac{u(t)}{1} = \frac{r \cos(\omega t)}{0,5 + r \sin(\omega t)}
\]

and so:

\[
\frac{u(t)}{0,5 + 0,5}
\]
Award 4 score points for finding similar triangles
For the rest of the proof: 2 score points

16 4 score points
The maximum divergence is reached as $t = -0.262 \, \text{s}$. This value corresponds with a measure of $\alpha = -0.524 \, \text{rad}$ or $-30^\circ$ if the rotational speed equals 2 rad/s.

Award 2 score points for finding $t$ from the graph.
Award 2 score points for calculating $\alpha$ and convert to degrees.

17 2 score points
The ‘decreasing’ part of the graph is almost a straight line.

18 4 score points
To answer this question, the program LINVOORT may have been used:

If $u = 0$, the speed is $-0.67 \, \text{m/s}$.

Award 2 score points for finding the speed at the right point on the graph.

19 4 score points
Within the backwards move, when the crank pin is in vertical position. This happens at an angle of $-90^\circ$ or $270^\circ$.

20 4 score points
To answer this question, the program LINVOORT may have been used. First find a zero point during the backward movement:

The maximum speed at this point is $2 \, \text{m/s}$.
Dear [interviewee],

[Representative of the local collaborating organization] has notified our team you will be interested to take part in our research on countries excelling math teaching on PISA 2018.

We highly appreciate your willingness to share your thoughts and help us to improve math teaching in Israel. We believe relying on information yielded from official documents only, without taking into account the voice of the teachers, cannot fully capture the essential factors leading [country] to its educational success. We are interested to hear your personal point of view on [country]’s math education.

Below, please find information about the current Cross National Research on Countries Excelling Math Teaching (CNROCEMT) research and about Yozma research center.

Please select the best date and hour for our online interview:

[Date and time options]

Looking forward to hearing from you (on a one-on-one Zoom meeting with [interviewer]).

[sender]

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A Cross National Research on Five Countries Excelling Math Teaching On PISA 2018

On December 3rd (2019) the Yozma (Center for Knowledge and Research in Education) team has reviewed the long anticipated PISA 2018 results. Israel’s placement as 39th in PISA 2018 world ranking and 41st in PISA 2018 mathematics ranking along with various additional related variables left us no choice but interrogating our misconduct in parallel with tracing the factors leading to success among countries excelling math teaching. Our committee has chosen five countries excelling mathematics (alphabetically ordered): Canada (Ontario), Estonia, the Netherlands, Singapore and Slovenia.

Research aims

1. Getting a better understanding of math teaching in [country] (with a focus on 7th-9th grades).

Project stages

1. As a basis for the research project, our team has written a literature review depicting the education system along with main mathematics teaching practices being at use in [country].
2. As a second step, The Yozma team invites four mathematics teachers from [country] to read his or her own country description (of approximately nine pages) and attend a 1.5 hours long one-on-one online interview. Participating teacher will be compensated for their time. As part of the interview, main suggestions and comments on the country description will be raised. More importantly, during the interviews teachers will be
encouraged to share their narrative on factors leading to his or her country’s mastery in mathematics teaching and teaching in general.

Confidentiality

Information collected by the project’s team will be used by two personnel only for the purpose of writing the research paper. No information provided by participants will be attributed to specific teachers without their approval. The Yozma team would like to mention the school name and/or the school district and, if approved, to add the teacher’s names as part of a thank you list which will appear at the end of the paper.

Schools and participants will also receive a copy of the full report, once the study is complete.

Administrative information

- Participating teachers should be ones who teach mathematics among 7th-9th grade students.
- Teachers will receive the literature review of approximately nine pages at least seven business days before the online interview.
- The online interview will be in the form of an open, unofficial conversation.
- Participation should not prepare for the interview or hold exceptional understanding or neither the education system nor mathematics teaching in their country.
- Participation in the research demands a dedication of approximately 2.5 hours total (which include both reading the paper and attending the interview).
- In appreciation for participants' time, after finishing the research task, they will receive a [value] gift card via email.

For further communication please contact [contact person]
Appendix 3. Interview form

Interviewee details (filled in throughout the interview)

1. Please tell me about your professional background
   - Highest level of education achieved
   - Subject mastery
2. Professional experience in years:
3. Teaching in grades:

Logistic questions

1. Math lesson’s usual length:
2. Number of math teaching hours per week:
3. Start and end hours of math classes:

Education system

1. What do you think are the challenges of the [country]’s education system?
2. What do you think are the strengths of the [country]’s education system?

Math teaching - general questions

1. How do you explain the increase in [country]’s math average score on PISA assessments?
2. How do you explain the high percentage of [country]’s top achievers in PISA?
3. Which parts of the [country] story documents caught your attention the most?
4. Have there been changes in math teaching during your tenure as a teacher?
5. What is the contemporary best practice for mathematics teaching?

Assessment

1. Components of math grade
2. What is the frequency in which you use tests, oral exams and submitted papers

Teaching tools

1. How much freedom do you have in setting your teaching curriculum?
2. What is your primary teaching resource? Who chose/approved this resource?
3. Do you use the same book among all math classes?
4. ICT equipment – availability, frequency of use
5. Do you use electronic teaching materials?
6. Does your school have a policy on the use of computers in mathematics instruction?

Teaching methods and tools for teaching in heterogeneous classes

1. Does your school conduct a test to identify students of high and low levels? - age
2. How do you motivate talented pupils?
3. What is the place of creativity enhancement in the teaching profession?
4. How do you build students’ confidence and positive attitude toward mathematics?
5. Does your school use grouping in math classes? Within class, between classes?
6. Do you sometimes teach similar content at different levels of difficulty?
7. [If the answer to Q7 was positive] Do you receive class plans at varied levels of difficulty or do you need to develop it yourself?
8. Does your school put special attention on the individual needs of particular students?
9. Do you allow gifted pupils to learn material at a deeper/higher level than their peers?
10. Do you allow gifted pupils to learn extra material?

Teaching methods

1. Memorization of rules, procedures and facts as a pedagogical technique
2. Group work
3. Relating the content being taught in class to pupils' everyday life
4. Homework policies - frequency of homework assigned, discussing homework in class
5. Independent knowledge acquisition in class
6. Linking mathematics with other subjects

Additional math learning opportunities

1. Additional (Enrichment/remedial/both) math lessons - topics, popularity
2. Competitions
3. Clubs
4. Research projects/ individual project

Professional development

1. Which professional development courses are being offered to mathematics teachers?
2. Are you supported by a mentor?
3. Have you gone through class observations/lesson plan by external entities?
4. Have you gone through class observations/lesson plan by principal or a senior staff member?
5. What does peer collaboration look like in your school?
6. Did you attend a course on teaching high achieving or gifted students?

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