Students’ perception about mechanical stress and what is most important for learning, during a practical task, using a digital interactive lab description.

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Background

- Mandatory Technology subject in the nine years of compulsory school
- Upper secondary school programme and about 8.4% choose technology (Skolverket, 2023b).
- Compulsory Introduction course in the technical program
- Solid mechanics has played an important role in the technology course plan and even though its role may have lessened it is still widely used
- Many studies have investigated how digital aids can help students performing practical tasks (Barrow & Rouse, 2009; Karlsudd, 2014; Usulu & Usulu, 2021).
- challenges, in learning solid mechanics is the learning of new terms and concepts like stress and strain.

Aim of the study

The aim of this study was to evaluate a material designed to support student learning. More specifically:

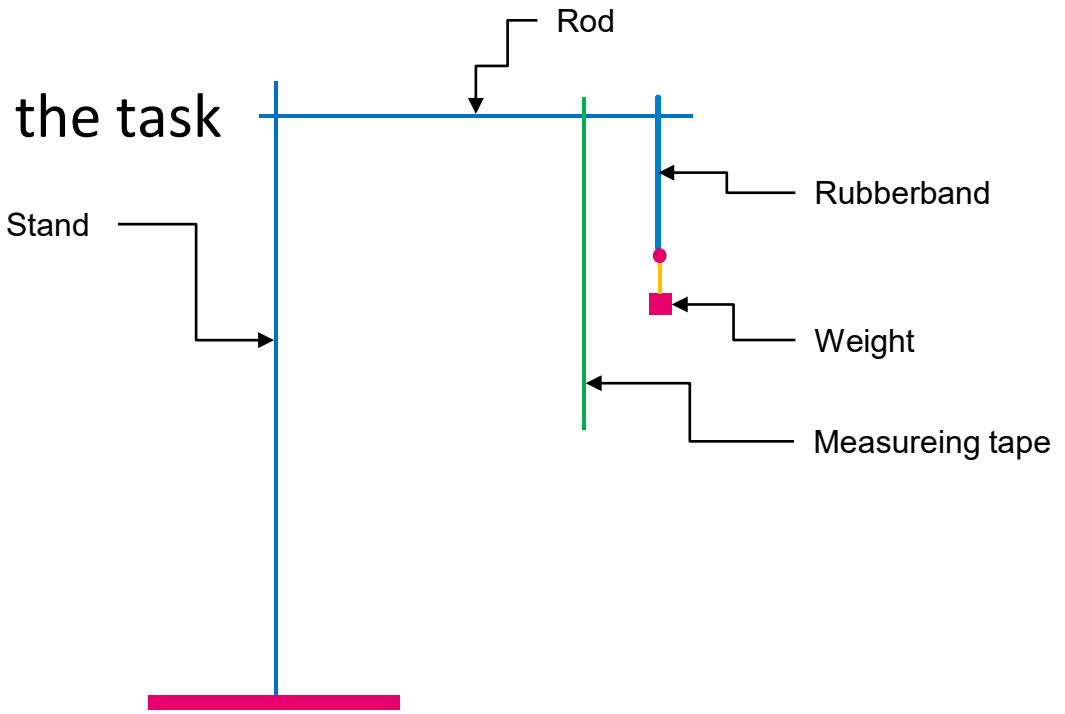
1. What do students know about mechanical stress before and after doing the experiment?
2. What do the students perceive as helpful in the material in their learning about mechanical stress?

Collected data

- One school
- 107 students divided in 4 classes
- Two questionnaires one before and one after a practical task
- 85 students responded both
- Mixed gender

Method 1

- Digital interactive instructions with digital links
- Simple tensile experiment
- Students got a stress strain curve for a rubber band and investigated the graph
- The students answered questions before and after the task
- They were divided in different teams/groups
- Thematic analysis (Braun and Clarke, 2006)



Principal drawing

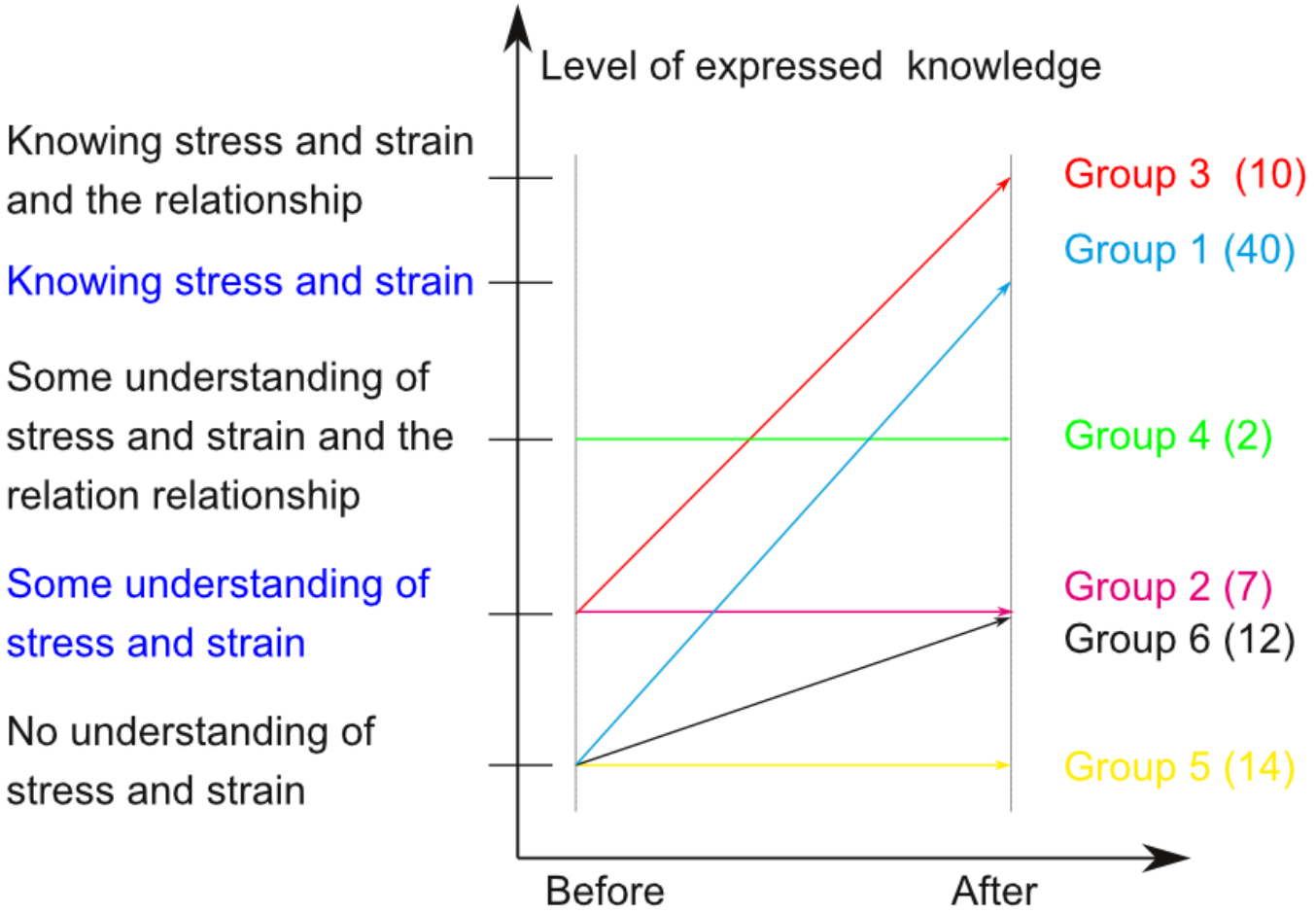
Questions in forms before and after the task

(i) 1) Mechanical stress occurs in a material when you try to pull out the material so that it becomes longer. Mechanical stress is force pushing on a surface that is perpendicular to the force. What do you know about mechanical stress?

(ii) 2) Strain occurs when pulling a material. Strain is how much you extend a material relative its original length. There is a relation between strain and elongation. What do you know about this relation?

(iii) 3) Stress and strain relate to each other. When you draw a graph (curve, as a mathematical function with appearance f(x)= x) that describes the relationship between mechanical stress and elongation, you get a certain appearance that is unique for the material being studied. What do you know about the graph? What does it describe?

Result



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Method 2

- The students were also asked to rate the importance of different learning aspects on a scale where six was the most important and one was the least

- A Oneway Anova analysis with post hoc (Ostertagova et al., 2013).

•statistically significant relations between classes, the perception groups with the same theme, and what the student rated of importance was investigated.

• Own preparation, description of the lab, Interactive links, formula book, course book, the teacher and execution of lab.

Result

Table 4. The importance of a) The digital links for the different groups
b) The teacher for the different groups. Rated 1-6 where 6 was the most important.

- There was not much difference in importance between for example teacher and digital links.
- there were significant differences between groups of students with different perceptions and different classes they belonged to ($p<0.01$)
- and, for the group versus teacher ($p<0.01$) . No significant difference with the digital links

Groups versus digital links	Mean	Std.
1	2.60	1.73
2	2.26	1.97
3	2.91	1.92
4	3.71	2.56
5	3.33	2.58
6	2.92	2.07
Groups versus teacher	**Mean**	**Std.**
1	4.25	2.12
2	2.00	1.83
3	2.83	1.70
4	2.25	2.32
5	2.39	1.98
6	3.00	1.99

Statistics

The different groups had different perceptions of mechanical stress before and/or after the performed task.

Group Class	1	2	3	4	5	6	Total
1	11	4	5	0	6	2	28
2	11	2	2	0	2	1	18
3	16	1	0	0	3	5	25
4	2	0	3	2	3	4	14
Total	40	7	10	2	14	12	85

Table 2. Number of students in the four classes divided in the different perception groups.

Groups	Own preperation	Describtion of lab	Interactive links	Formula book	Course book	The teacher	Execution of lab
Mean	2.76	2.51	2.96	2.78	3.25	2.79	3.24
Std	0.56	0.76	0.47	0.45	1.16	0.74	1.16

Table 3. The importance of different aids during the lab for different perception groups, rating 1 to 6 was most important

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Discussion

- No significant correlation digital aids
- Significant correlation with group-teacher, group-class
- Maybe with less help from the teachers we could have investigated how much help the digital aids gave to understand the concepts stress and strain.
- The importance of using the digital links and exactly how it is used thus needs to be further investigated.

Result

Perception group	Example of an answer before the task	Example of an answer after the performed task
Group 1 **Before the task: Students know nothing, or very little, about mechanical stress, strain, or about the relationship between the two. They expressed this by writing things that were wrong or by not writing anything at all.** **After the task: Students express some understanding of the concept mechanical stress but no or very little understanding of what how affects material or the relationship to strain. They could also have expressed some understanding of the relationship but nothing about the concept of strain.**	“No idea, no clue, do not know”	“It's the power divided by the area in mm^2.” “nothing, doesn't understand what I should have realized with the graph”
Group 2 **Before: Same as group 1** **After: Express some understanding of mechanical stress, strain and the relationship between them.**	“Nothing, nothing special”	“It depends on epsilon and the stress.” “It is the mechanical stress. Elasticity”.
Group 3 **Before: Express some understanding of the concept mechanical stress.** **After: Express some understanding of strain and the relationship between strain and mechanical stress. The student also expresses an understanding of the concept mechanical stress.**	“Looked a little at it. I know F/A = some stress. Beyond that I do not know more.” “I know there is a relation between them. I do not know how you use it or what equation I should use.” “I know that the graph probably gets a bigger y value the more stress you have and enough stress result in that the material will break.” “It depends a lot on different material.”	“I know now that F/A = stress. Thus, when you pull a material the stress will increase depending on how big area you have.” “I know now that strain is depending on the elongation and the original length of the material you had.” “I know that the graph descries the correlation between stress and strain.”
Group 4 **Before: Express an understanding of the concepts mechanical stress and strain and the relation between them.** **After: They do not express any difference in understanding before the task as compared to after the task.**	“A force on object that you pull.” “A Rubber band.” “But I do not know more about this.” “Do not know anything but my guess is that there is a relation between the length of the material and the force you pull with. There is also a relationship with what material it is. Rubber can stretch more than stone.” ”Have absolutely no idea.”	“An object is stretched when a certain stress occurs on the object. The more stress, the more strain.” “It describes the relationship between the strain and stress.”
Group 5 **Before: Express no understanding of the concepts stress and strain or the relation between them** **After: Express no understanding on the concepts stress and strain or the relationship between them.**	“Nothing”. “The stress increases when you stretch something. “ “High stress means that the object you are pulling stretches a lot.” “Proportional increase in the graph.”	“Mechanical stress in a material occurs when you try to pull out the material so that it becomes longer.” “Stress is a force that is applied on a surface that is perpendicular to the force.” “Proportional relation. It should be equally constant.”
Group 6 **Before: Express some understanding of the concept mechanical stress** **After: No difference in understanding after the task than before.**	“Mechanical stress in a material occurs when you pull a material, so it gets longer.”	“You calculate stress by F/A = the force divided by the area.”