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# A Developmental Study of Promisingness Judgments

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## Statement of the Problem

The capability of recognizing promisingness is one key manifestation of "creative expertise." It is developed over time as people engage in creative practices, taking risks and learning from the successes and failures. To help students practice promisingness judgments, a "promisingness" tool was developed and integrated into Knowledge Forum. Recent design experiments with this tool showed that young students could make promisingness judgments that facilitated knowledge advancement in their community (Chen et al., 2012). This poster reports another strand of research which aims to unpack the developmental aspect of promisingness judgments as well as its relationship with domain knowledge.

## Research Questions

We believe that promisingness is contextualized and cannot be decoupled from what the judgments are for. Accordingly, we consider different criteria of promisingness judgments in this study and aim to answer two main questions:

1. Can developmental patterns in promisingness judgments be identified based on selections of ideas according to various criteria, such as "promising for achieving deep understanding" and "promising for making a scientific breakthrough?"
2. If there is a developmental trajectory of such promisingness judgments, how is it related to domain knowledge in the relevant subject matter?

## Idea Evaluation Survey

To tackle these two questions, a survey that included the following three sections was designed.

- **Demographics**
  age, level of expertise in physics, and institutions
- **Quiz section**
  10 multiple choice questions related to optics
- **Idea evaluation section**
  16 ideas about "reflection" and "refraction" in optics on 4 predefined levels of promisingness

| Levels | Examples |
|---|---|
| 1-Not quite right | The convergent lens increases the speed and energy of the light. That's why it can make a piece of paper on fire. |
| 2-Simple fact | When light hits a mirror, the angle of incidence equals the angle of reflection. |
| 3-Deep understanding | Refraction is the bending of light when it passes from one kind of material into another. Because light travels at a different speed in different materials, it must change speeds at the boundary between two materials. |
| 4-Possible breakthrough | Three-dimensional solar cells on solar panels can trap sunlight inside a structure, making light bounce around until it is converted into electricity. This makes it more efficient in converting sunlight to electricity. |

## Participants

Five groups of participants were recruited.

| Groups | Description |
|---|---|
| Grade 4 | 20 students from a school in Toronto; just learned a science unit about optics this year |
| Grade 5 | 21 students from the same school as Grade 4s; had not learned the optics unit in Grade 4 |
| Grade 7 | 23 students from a bilingual school in Columbia; use English in science classes; most students learned optics two years ago |
| Adults | 7 participants from diverse academic background; did not have a post-secondary physics background |
| Experts | 5 faculty members or graduate students from a physics department |

## Can developmental patterns be identified?

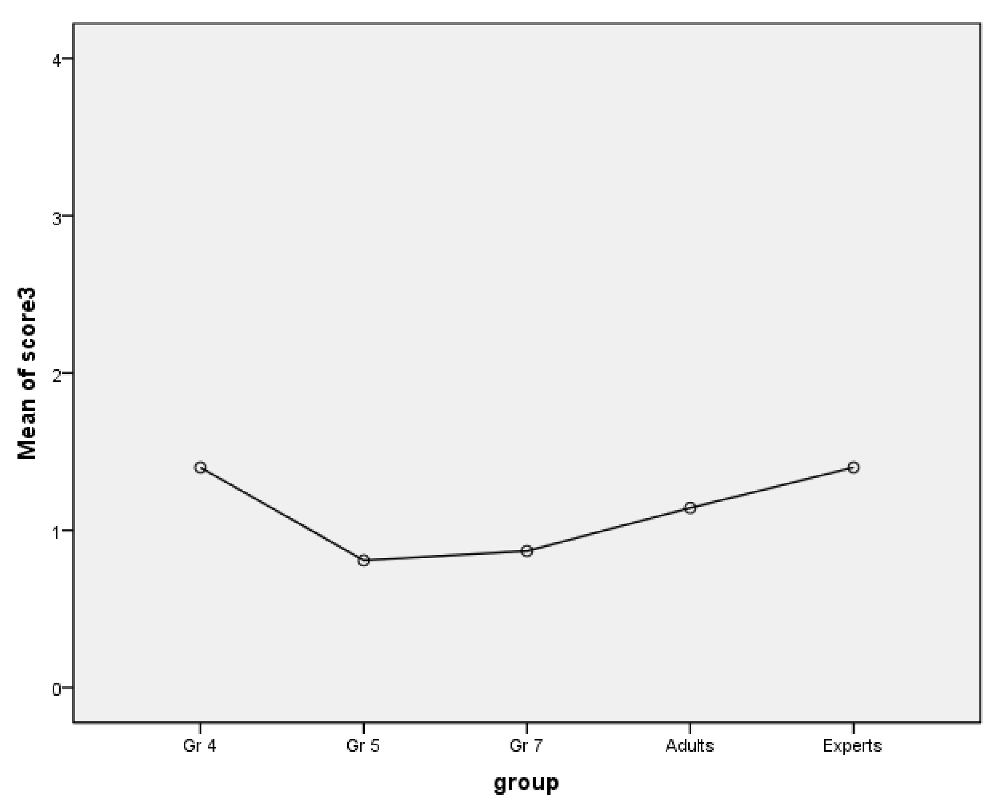
One-way ANOVA tests on a number of variables were performed to assess whether participants' performance in idea evaluation tasks could be predicted from the group.

First of all, the **overall performance** of different groups on the idea evaluation task was significantly different, no matter whether it was measured by the total number of "hits" ($F(4, 71) = 16.92$, $p < .001$) or Pearson correlation with the "correct" answers ($F(4, 71) = 9.34$, $p < .001$).

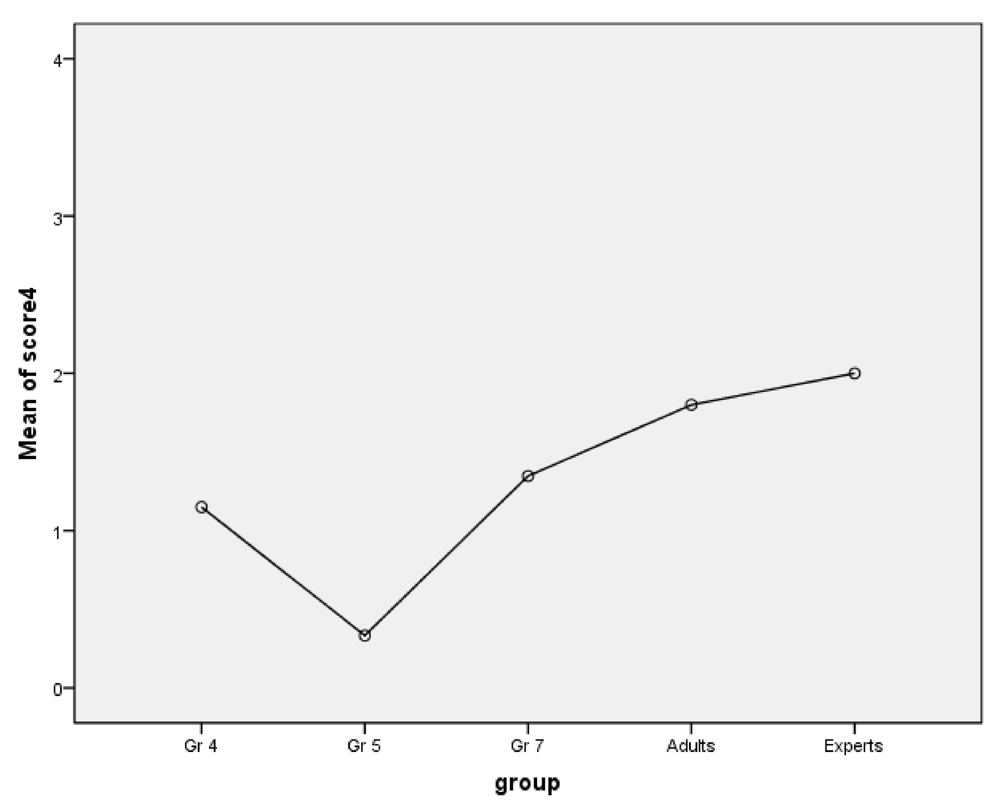
**For performance on specific levels**,

- Different groups performed significantly differently on evaluation of three idea levels including "1-Not quite right" (score1, $F(4, 71) = 24.99$, $p < .001$), "2-Simple fact" (score2, $F(4, 71) = 3.24$, $p < .05$), and "4-Possible scientific breakthrough" levels (score4, $F(4, 71) = 4.10$, $p < .01$);
- However, no significant difference was found on the level "3-Deep understanding" (score3, $F(4, 71) = .34$, *n.s.*).

**Level 3–Achieving deep understanding**




**Level 4–Making scientific breakthrough**

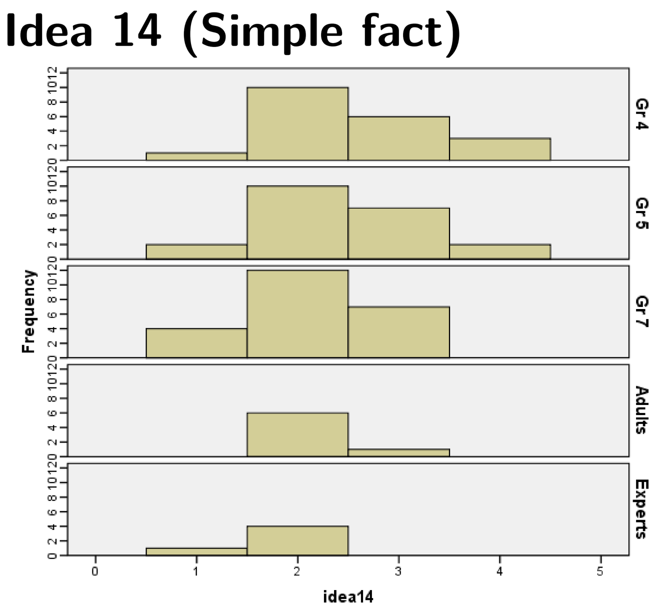



## A microscopic analysis of participants' evaluation of ideas

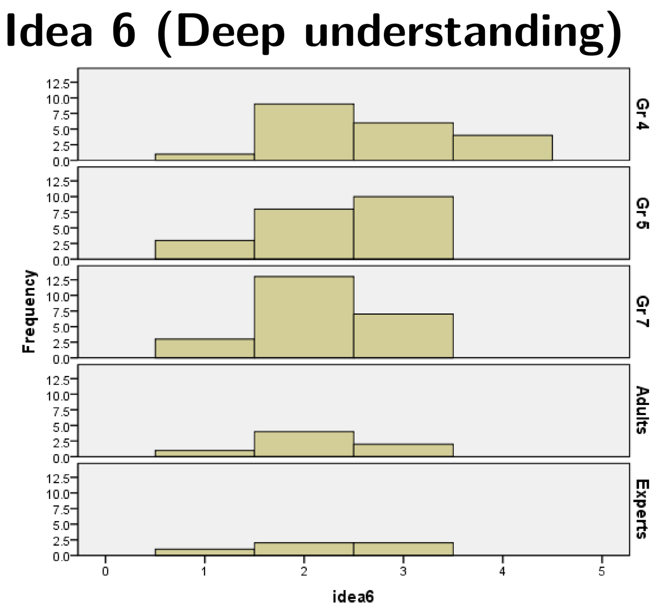
Frequency and histogram analysis was conducted to get a microscopic view of evaluation on each idea.

- Firstly, for ideas on the "1-Not quite right" level, which were all classic misconceptions, grade 4, 5 and 7 students have made a lot of mistakes recognizing them as "simple fact" or "deep understanding," while experts could recognize all of them as misconceptions. This result implied a significant gap of domain knowledge between kid and adult groups.
- Second, ideas from the "2-Simple fact" level did not have much discrepancy across all groups; most participants in each group made the "correct" judgment (see Idea 14 for example). However, a number of young students had difficulty distinguishing them from "deep understanding" or "possible scientific breakthrough."
- For ideas from the "3-Deep understanding" level, deep understanding was easily confounded with "simple fact" for all groups (see Idea 6 for example).
- Lastly, ideas from the "4-Possible scientific breakthrough" had a lot of discrepancies. In some cases experts brought alternative theories that might challenge scientific breakthroughs and deem them incorrect, while non-experts could tag an actual breakthrough as "not quite right" because they thought it was impossible (see Idea 13).

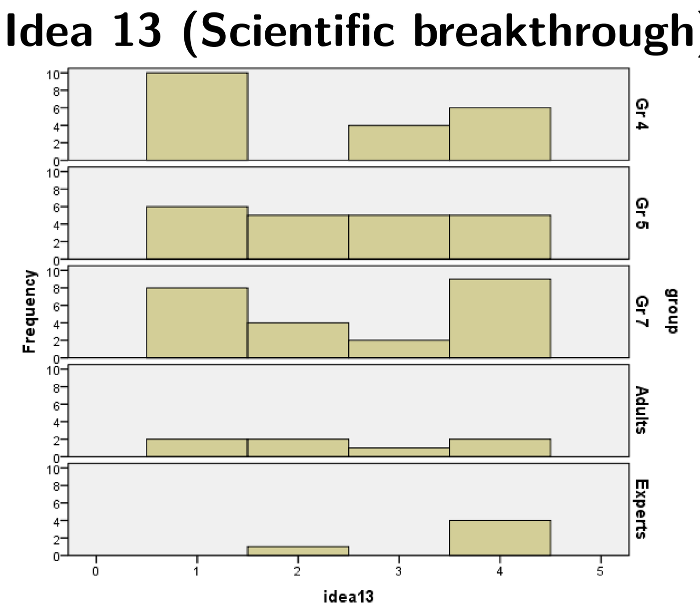
**Idea 14 (Simple fact)**




**Idea 6 (Deep understanding)**




**Idea 13 (Scientific breakthrough)**




## Which factor matters: age difference or domain knowledge?

The microscopic analysis implies an impact of domain knowledge on promisingness evaluation. A participant's performance in evaluating classic misconceptions (i.e., level 1 ideas) and the quiz section could be both used to measure domain knowledge. Previous analysis already found a significant difference in evaluating level 1 ideas among groups. One-way ANOVA was further applied on the quiz score and a significant difference was also identified, ($F(4, 71) = 6.84$, $p < .001$).

Correlation analysis was conducted among variables related to age, domain knowledge and the capability of making promisingness judgments (see Table below). Overall, the capability of judging promisingness in the context of scientific breakthroughs was significantly correlated to both age and domain knowledge. However, since age and domain knowledge are also correlated, it difficult to determine which factor had a greater impact on promisingness judgments.

| Variables | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1. Age | - | | | | |
| 2. Quiz | .42** | - | | | |
| 3. Score1 | .77** | .30** | - | | |
| 4. Score3 | .13 | -.06 | .05 | - | |
| 5. Score4 | .25* | -.06 | .23* | .11 | - |

Table : Correlations between Measures

## References

Chen, B., Scardamalia, M., Resendes, M., Chuy, M., & Bereiter, C. (2012). Students' intuitive understanding of promisingness and promisingness judgments to facilitate knowledge advancement. In J. van Aalst, K. Thompson, M. J. Jacobson, & P. Reimann (Eds.), *The future of learning: Proceedings of the 10th international conference of the learning sciences (ICLS 2012) – Volume 1, Full Papers* (pp. 111–118). Sydney, Australia: ISLS.

## Future work

Data analysis identified a few issues with the current design of the developmental survey. In future revisions, we will try to:

- improve the promisingness scale to more accurately reflect the meaning of promisingness and include other important criteria
- revisit ideas used in this survey with help from domain experts
- revise quiz items to more accurately measure participants' domain knowledge
- include more diverse age groups, especially 15- to 18-years-olds
- collect think-aloud data for deeper analysis of cognitive processes involving promisingness judgments