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Why Asset-Based Approach to Teaching Is More Effective than the Usual Deficit-Based Approach, and Why the New Approach Is Not Easy to Implement: A Simple Geometric Explanation

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1. Usual Deficit-Based Approach to Teaching

- Traditional approach to teaching is based on uncovering deficiencies in students' knowledge.

- Based on the results of pre-test or a midterm exam, the instructors:

  - learn about the topics that the students have not yet fully mastered, and

  - concentrate on these topics.

- For example, a graduate computational science program usually attracts both:

  - computer science students who want to work on applications of computing, and

  - science and engineering students, who would like to improve their computational skills.

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2. Deficit-Based Approach to Teaching (cont-d)

- In the usual deficit-based approach, when we teach a computer science course to all these students:

  - since science and engineering students are less knowledgeable in computer topics,

  - we spend extra time explaining these topics to non-computer science students.

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3.   Asset-Based Approach

- Teaching can be made more efficient if we take into account that:

  – while students from engineering and science may lack some programming skills,

  – they usually have a much better understanding of the corresponding physical situations.

- This understanding often helps them:

  – get a good idea of what all the intermediate computational results should be – and thus,

  – catch possible mistakes at an early stage.

- In general, this asset-based approach – using advantages that individual students have – is efficient.

4. Asset-Based Approach Is Not Easy to Implement

- At first glance, the asset-based approach sounds reasonable.

- However, it is not yet as widely spread as it should be.

- The main reason for this slow spread is that, as experience shows, this approach is not easy to implement.

- Why is asset-based approach useful?

- Why is it not easy to implement?

- In this talk, we provide a simple geometric answer to both questions.

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5. The Goal of Teaching

- For each class, we want a student to be knowledgeable and skillful in all the studied topics.

- For each topic, we can describe the student's current level of knowledge and skills by an appropriate grade.

- Let's visually represent the student's knowledge in a topic.

- It is natural to take a point that corresponds to this particular grade on a vertical straight line.

- The better the grade, the higher the point.

- To represent the student's knowledge in all the topics, it is reasonable to consider:

  − several parallel vertical lines

  − corresponding to different topics.

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# 6. The Goal of Teaching (cont-d)

- Here:

  - similar topics will be represented by nearby lines, while

  - lines corresponding to very different topics and subjects should be distant from each other.

  - Our main objective is to make sure that every student has excellent knowledge and skills in all the topics.

  - Then, points describing the student's knowledge in different topics are all on the same (highest) level:

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7. Ideal Situation

- In the ideal situation, a student is moving steadily.

- So, the student has the same original level of knowledge in all the subjects.

- In this case, the student's original levels of knowledge are also described by points on the same level.

- Of course, this original level is lower that what we want at the end of the class.

- The goal of teaching is to move the student's knowledge:

  - from the lower points (corresponding to original level of knowledge)
  - to the higher point which corresponding to the desired level of knowledge

8. Ideal Situation (cont-d)
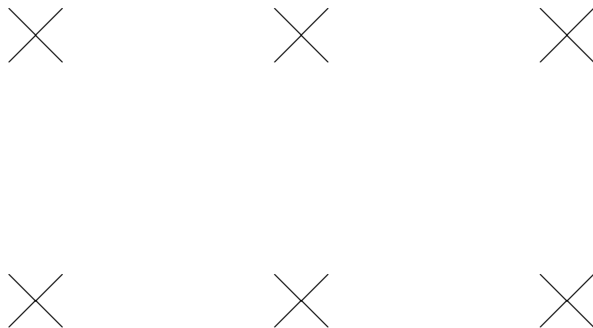
- To reach each point of the desired state as fast as possible, it is reasonable:

  - to start with a point from the original state

  - which is the closest to the desired point.

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9. Ideal Situation (cont-d)

- In the ideal case:

  - all points describing the original state are on the same horizontal level, and

  - all the points describing the desired state are on the same horizontal level.

- In this case, for each desired-state point, the closest starting-state point is:

  - the one on the same vertical line, i.e.,

  - the one corresponding to the same topic.

- Thus, in this case, the traditional deficit-based approach makes perfect sense: for each topic:

  - we find out the students's deficiencies and

  - work on them.

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10. Ideal Situation (cont-d)

11.   Real-Life Non-Ideal Cases

- In real life, a student rarely has the same level of knowledge in all the topics.

- As a result:

  - if for some topic, the current level is too low (i.e., is a deficiency),

  - the closest point to the desired level of this topic is *not* the current state of this topic,

  - but rather the current state of some nearby topic – in which the student's knowledge is much higher,

  - i.e., of the topic which is an asset.

12.   Real-Life Non-Ideal Cases (cont-d)
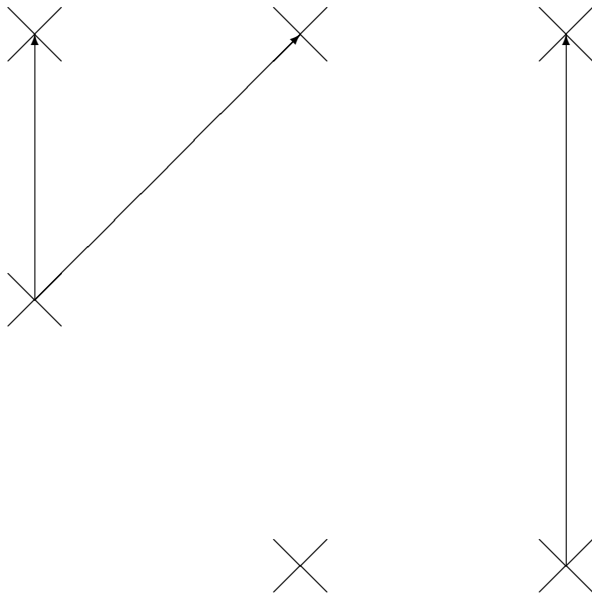
- This is exactly the idea behind asset-based approach to teaching!

- Thus, we explain efficiency of asset-based approach.

13. Short-Term vs. Long-Term Approaches to Teaching

- Day-by-day teaching is mostly concentrated on short-term goals.

- Mostly, when we teach:
  - we think of the topic that we teach this week, and
  - we want to make sure that this particular topic is well understood.

- Of course, we also think long-term, in terms of how this topic is related to other subjects.

- However, such long-term considerations usually take less of our time than day-by-day short-term teaching.

14. Short-Term Teaching Leads to an Overemphasis on Deficiency-Based Learning

- In geometric terms, an emphasis on short-term effects means that:

  – we mostly consider objective points

  – which are close to the points that describe the current state of the student's knowledge.

- In this case, the closest point to each desired topic is the student's current knowledge of the same topic:
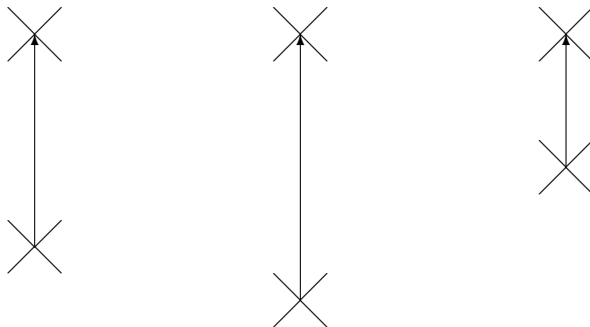
15. From the Long-Term Viewpoint, However, Asset-Based Approach Is Better

- If:

  - instead of thinking short-term and concentrating on this week's goals,

  - we think of the general goal of the class (or even the general goal of the whole program),

  - then the distance from the current state to the desired state increases.

- How will this affect teaching?

- Let us consider a real-life case when:

  - the student's knowledge in one topic is b points lower than

  - in the neighboring topic – of distance n from the first one.

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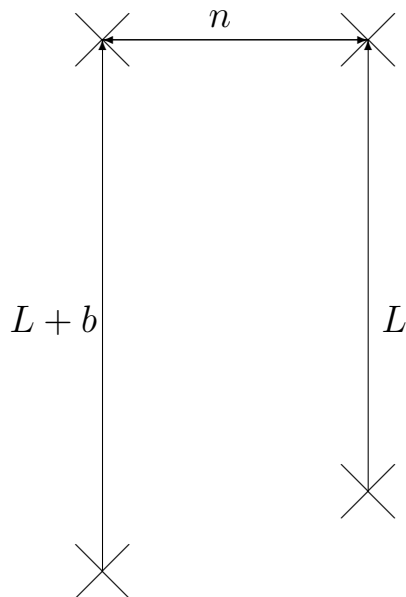
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16.   Long-Term Viewpoint (cont-d)

- We want the student to eventually reach the same level on both topics.

- Let's denote the distance between the current and desired levels for the second topic by L.

- Then for the first topic, the distance is $L + b$:

17.   Long-Term Viewpoint (cont-d)

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18.   Long-Term Viewpoint (cont-d)

- In this case, the traditional deficiency-based approach means that:

  – to get to the desired state of knowledge of the first topic,

  – we start with the current (deficient) level of knowledge in this topic.

- The distance needed for this transition is $L + b$.

- In contrast, the asset-based approach means that:

  – we start with the topic in which the student originally has an advantage,

  – i.e., we start with the second topic.

- The corresponding distance is $\sqrt{L^2 + n^2}$.

19. Long-Term Viewpoint (cont-d)

- The asset-based approach is more efficient if $\sqrt{L^2 + n^2} < L + b$, i.e., equivalently, when

$$L^2 + n^2 < L^2 + 2L \cdot b + b^2.$$

- This, in its turn, is equivalent to $2L \cdot b > n^2 - b^2$.

- For sufficiently large L, this inequality is always true.

- Thus, if we consider a sufficiently long-term approach, we should use the asset-based approach.

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20. This Explains Why Asset-Based Approach Is Often Difficult to Implement

- As we have shown, for the asset-based approach to be efficient, we need to consider long-term objectives.

- However, long-term approach is more difficult to implement:

  - instead of simply selecting parameters characterizing one week's teaching,

  - we need to take into account teaching for all this long period of time.

- This explains why asset-based approach is not easy to implement.

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