A PERSONAL APPROACH TO LEARNING AND INSTRUCTION

ALYSSA WISE

R511

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INTRODUCTION

People learn in different ways in different situations when different tasks are required of them. In this discussion I limit the scope of my learning theory and its instructional implications to the very narrow audience of High School Physics students in their junior and senior year. I taught at this level for three years and the opinions expressed below are primarily a result of what I learned during this time. My ideas have also been influenced by my experience as a Physics student, as a student in general and by the learning and instructional theories we have discussed in the recent weeks. Many of these ideas expressed below can be successfully applied or extrapolated to other disciplines, but I leave that discussion for another time.

GOALS

I think that it is important to clarify is the goal of instruction. While perhaps the supposed goal of education is the constructivist objective of preparing students to use and integrate the skills they learn in the real world, I think the operational goal often becomes learning in the abstract sense, for the “sake of learning” and to pass a test. In my class I had three major goals for my students. In the first place, I was given the charge of preparing them to take the International Baccalaureate examination at the end of their two years of study and of course I wanted them to succeed in this endeavor. In the second place, I wanted my students to develop critical thinking and analysis skills for both problem solving and investigational situations that they would be able use not only in Physics, but also in other disciplines. Finally I wanted my students to be able to make the connection between the theoretical and procedural knowledge they learned in my class and real world phenomena.

Physics explains our world, but so many physics classes teach the information in a vacuum, not showing how it explains the real world and not worrying about when it does not appear to. Note that at no point did I consider one of my goals to be to prepare my students to be physicists or engineers. I wanted to expose them to these fields, but if this is the route they choose, they will learn be prepared for these occupations much more in depth down the road. I feel that one of the mistakes that constructivists make is that they seem to view the “meaningful” teaching of a subject as related to its occupational use, which they term “expert use”. But I do not think that the goal of learning information is always to use the domain as an expert would. In truth, how many of my high school students will go on to become physicists or engineers? I would say three to four at the most. For the rest of the students, the ways in which they will need to use physics in the real world have nothing to do with the way a physicist would. They need a “common man” use so that they can explain why things happen and use their knowledge to troubleshoot problems they may encounter. This “common man” use is much more important and useful to them than the ability to use the information as an “expert” would. I think the same argument can be made for many other disciplines, the majority of students need to be able to use math in everyday ways more than they need to solve complicated proofs. The majority of students need to use foreign language to communicate, not as a linguist would dissect it. This is not to say that these "expert uses" can't add to and enhance a common man use, but that if we are to talk about real and authentic learning experiences, perhaps "expert use" alone is not a complete standard. Thus, with these as my goals, I present some thought about how students learn Physics and their implications for instruction.

LEARNING & INSTRUCTION

*Students learn physics best when what they learn has meaning for them in **their** world…*

Students <u>can</u> be interested in learning when they see how the material they learn is used by experts in the real world, but many times they put this information into a "that is there and this is here" mentality. In other words a use that is real and meaningful to us as adults may seem impossibly distant for the students. In teaching Physics I have found that showing them how electrical circuits cause a hand buzzer to work, or why a computer screen is slightly rounded motivates them more and helps them anchor and retain the material much more than talking about how an electric plant 'produces' energy or how physicists use electrical devices to make measurements.

…therefore instruction should always be anchored and connected to students' experiences.

In Physics, this is a relatively easy task. Using the concepts (and formulas!) to explain things that the students have always wondered about is an extremely useful tool. It is important to present at least one example of this at the beginning of a unit, and not just as an 'application' after the fact, to let the students know ***why*** they are learning what they are learning and get them involved form the start. By presenting a real world example (explained, or left open ended) you let the students begin to connect what they are learning with the real world as they go along as an integral part of the learning process.

Students learn physics best when what they learn makes sense…

There is nothing more frustrating for a student who doesn't understand to be told "well that is just the way it is". When a physics demonstration doesn't turn out as planned, the temptation to say "well what is should have done was …." is very great, but this pushes the material into the realm of the abstract "should" category and it becomes "textbook" knowledge that they will not try to apply in the future and they will learn only because the teacher says to. Students enjoy the learning endeavor because it makes sense out of things and everything we learn does make sense at some level. Sometimes it is a very complex level and sometimes it is based on a set of assumptions or rules which are equally complex, but there is logic behind it all.

…therefore instruction should always explain "why".

It is true that science is not an exact discipline and that to instill students with the idea that the 'why' is a fixed and thoroughly understood reason is not desirable. At the same time, teachers need to use the current understanding to help students find a way to make of the information. This understanding is an ***important part*** of the learning process, not just "enrichment". When the explanation is too difficult to explain in full, a modified reasoning, or even a "fudging" of the information is better than no explanation at all. In this case I think a slightly inaccurate reasoning can be helpful as long as it does not cause cognitive confusion in other areas.

Students learn physics best when what they learn is concrete or based on something concrete…

For a teacher who understands something at the theoretical level, the most elegant explanation is clearly the abstract one that shows the whole view of the phenomena. For a student who doesn't know the material, this is the worst place to begin. The abstract view may be an excellent end goal, but without concrete examples to ground it, most students cannot grasp it in isolation. The concept of a force can be memorized, but students will truly understand it when it is introduced after they have learned about a broad range of forces to pin the idea to.

…therefore instruction should proceed from the concrete to the abstract.

Using Dale's cone of experience to work from the bottom up (generally speaking) is important in the sequencing of instruction. Presentation of the abstract concept first as a type of advanced organizer can be a very useful tactic, but to elaborate upon the idea without concrete examples is time wasted. Many teachers base their understanding of abstract concepts on underlying prototypical concrete examples and they need to allow their students to do the same. Many times, with simpler concepts, students can deduce the abstract concept themselves after learning about the specific examples. Even when this is not the case, the concrete examples are a crucial foundation for understanding the abstract idea.

Students learn physics best when what they learn is connected to something they already understand…

Using familiar territory to introduce the new allows the students to do less cognitive work. In the same way that connection to the students' world pulls the learning out of isolation, connecting new knowledge to old allows students to put the knowledge into an already existing framework, or to expand a framework instead of starting from scratch and reinventing the wheel each time.

*…therefore instruction should strive to show the **existing** connections between new knowledge and old.*

These connections work well both when they are content based (adding knowledge serially) or analogy based (adding knowledge in a parallel structure). These connections do not work well when they are contrived. As David Merrill points out using the example of themes in school, "when [they] are irrelevant to the content of instruction, they activate inappropriate mental models, and may actually interfere with, rather than facilitate, instructional effectiveness" (Merrill, 2001, p 6) There is nothing better than a good analogy and nothing more confusing than a poor one.

Students learn physics best when they have, or create, a framework for holding the information together…

The amount of information that students are asked to know is overwhelming and cannot be remembered in isolation. Apart from the problems this creates in integrating knowledge for problem solving and application, the sheer task of retention is also made more difficult than necessary. Frameworks allow students to store information in a logical and easily retrievable manner and correct frameworks inherently contain the connections between the concepts, which is content in and of itself. The connections between force, acceleration and velocity must be understood if a student is to truly understand any one of these concepts.

…therefore instruction should focus on the connections within the content.

Whether such frameworks should be given to the students or constructed by them is a question that I have yet to answer. Giving the students an advanced organizer or guiding them towards a preconceived notion is a powerful tool for learning. However, the constructivist idea that any framework that the students devise that works successfully is useful also seems plausible. Regardless of this question, frameworks provide an important tool for the students to retain material, understand the connections inherent in it and recall it easily.

Students learn physics best when what they learn is challenging, but not overwhelming …

The revelation that students do no like to work on trivially easy tasks should not be surprising. Students are more active and more engaged when they need to put effort into their work. When this does not happen, the work is completed on "auto-pilot". Many students complete long easy worksheets without even turning their cognitive attention towards the task at hand. Quantity is not the only way in which a task can be overwhelming, making a task too difficult, or not giving the students the requisite pre-knowledge is frustrating for them. Especially at the beginning of learning, students need a strong base of material to draw upon when they are asked to perform ill-defined tasks.

…therefore instruction should challenge students in the "proximal range" of their development and not be excessive in quantity.

My teaching mentor's philosophy was "Give them one problem for each variation, if they can do it once, they will be able to do it again". I always felt that one was not quite enough, but after two or three examples, the repetition is no longer helpful to the students. The fallacy that more practice is always better is a strong force in teaching practice and one with which I strongly disagree.

In terms of difficulty level, teachers need to find the level at which their students will be challenged, but not overwhelmed. A sufficient base of material to draw on is also important in helping student's meet the challenge. The constructivist attitude that this information will be learned along the way as the needed does allow the student to build information gathering skills that are very valuable in the real world, but even an expert in the real world has a large knowledge base to draw upon which helps them begin a task. I think that giving learners a knowledge base does not detract from the learning during the process, but does give them a relevant background and is consistent with "expert use" practices.

Students learn physics best when they are actively involved in the learning process…

This principle has been stated many times, but I feel that it is worth emphasizing due to its importance. Students learn by doing. When I studied physics at the collegiate level, we would have theoretical lessons with examples for an hour three times a week and at the end, it was assumed that this knowledge could be easily transferred into the ability to complete problem sets. This was not a trivial task. Many of my physics students would make the mistake of studying for a test by looking over the homeworks that had completed earlier. They would inevitably come out of tests looking upset and explaining that when they had looked over their work they had understood how to do the problems, but that during the test, they could not replicate the process.

…therefore instruction should give students the opportunity to practice.

Practice with feedback, coaching, scaffolding and what ever it takes to get students comfortable performing the task they need to learn is the most powerful tool in teaching. Practice should not be relegated to homework which is then reviewed or corrected later. Students need immediate and individual feedback ***while*** they are in the middle of the cognitive act in order for them to correctly grasp the material.

Students learn physics best when they have the opportunity to physically move around…

I am referring to students of all ages here. Labs and hands-on activities are great, but in fact any sort of physical stimulation keeps learners attentive and interested. The institution of school has converted learning into a very sedate process where students sit in a chair. In my classes, students jump at the chance to be the one to write on the board for the sheer change of position. Fidgeting during class is often a result of lack of physical stimulation as much as the classic attribution to boredom. My teaching mentor made it a rule to have the students our of their seats at least once during every class and his was the only hour and a half class in which the students did not clamor for a 10 minute break in the middle!

…therefore instruction should give students the opportunity to physically move.

This can be accomplished in a variety of ways ranging from the trivial to ones which also enhance learning. In either case the goal is reached. Teachers can have students take turn writing on the board, have them move into groups, use a demonstration where students need to move to the back of the room, take mini-field trips within the school. In Physics the possibilities to integrate the material are endless such as having student perform push-ups or jumping jacks while asking if "work" (the physical concept) is being done. Even when the movement is trivial in respect to the content, such as having all the students switch desk, the students are revived and more ready to learn afterwards.

Students learn physics best when they are motivated…

You can't make a student learn if they don't want to. Every teacher knows this. Whether the motivation is an external one such as grades, or an internal one, such as curiosity, the student must want to learn if they are going to master the material. There is no getting around this principle

…therefore instruction should motivate students in as many ways as it can.

There is a plethora of ways in which teachers can motivate students, from external rewards and punishments to the internal ways suggested by Keller's ARCS model, but what I have always seen as the most powerful motivator within the teacher's control is caring. Nothing motivates students more than when they know that the teacher cares about and is invested in their progress. There do exist those self motivated students who can learn for themselves, or those who have a parent who cares, but for the rest, know that their learning is important to the teacher makes them invested in the learning process in a multitude of both internal and external ways. The power of this tool should not be under estimated.

CONCLUSION

In this paper, I have touched upon what I consider some of the most important factors in learning and instruction. The list is not comprehensive, and there are many other which are important as well, but one must draw the line at some point and I feel that these principles as a group capture an image of what I conceive to be important in learning and therefore in instruction. These principles are not a checklist for success or an organized list of the elements of instruction, but rather a group of ideas that are meant to convey a holistic conception of how learning best occurs and its implications for instruction.

REFERENCE

Merrill, M. David. (2001). First Principles of Instruction. Retrieved October 10, 2001, from Utah State University, ID2 (Second Generation Instructional Design) Web site: http://id2.usu.edu/