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Assessing the Impact of Student Learning Style Preferences

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Students express a wide range of preferences for learning environments. We are trying to measure the manifestation of learning styles in various learning environments. In particular, we are interested in performance in an environment that disagrees with the expressed learning style preference, paying close attention to social (group vs. individual) and auditory (those who prefer to learn by listening) environments. These are particularly relevant to activity-based curricula which typically emphasize group-work and de-emphasize lectures. Our methods include multiple-choice assessments, individual student interviews, and a study in which we attempt to isolate the learning environment.

Introduction

A learning style is a biologically and developmentally imposed set of personal characteristics that make the same teaching (and learning) methods more effective for some and less effective for others [1]. These include techniques, approaches, and processes[2], but also innate physiological factors, experience, habit, and training. Learning styles are consistent with personality types, but there is more to one's learning style than personality. Common learning styles diagnostics range from the Jungian-based Myers-Briggs personality type test[3] to more detailed attempts to discern environmental and physiological effects [4, 5]. As these rely on student self-reporting, they suffer greatly from the fact that students often don't know when they learn, let alone how they best learn. Students that claim to learn best by listening often mean that they are most comfortable following a competent lecturer. This comfort often does not correlate with learning (in fact, it sometimes is anti-correlated with learning)[6]. As such, it is perhaps more accurate to talk about learning style *preferences (LSP)*.

To accommodate different *LSP*s , many research-based physics curricula [7, 8, 9] present information in a variety of representations [10, 11]. Motion, for example, is described with words, pictures, graphs, and, ultimately, equations. As measured by standard conceptual evaluations [12], these courses produce learning gains significantly larger than traditional courses. These learning gains are experienced by all segments of the class, with stronger students benefiting the most by the reformed curricula [13].

A study on deaf students [14] found a correlation between learning style preference and course grade, with students who have a more participatory approach to learning earning higher grades. Dunn, et al. [2] also found that accommodating learning styles could boost student performance by almost one standard deviation. Felder has analyzed [15, 16] student performance in introductory engineering classes in the context of *LSP*s. He found that extroverts performed almost one full letter grade higher than introverts, and speculated that the cooperative learning benefited the extroverts. He also found a significant gender gap [16] in performance between students who tend to make judgments subjectively and personally (Jungian *feelers*), but no gap between those who approach learning more objectively (Jungian *thinkers*). Addressing *LSP*s may begin to remedy the under-performance of women in introductory physics classes [17, 18].

Multiple-choice *LSP* assessments

Dunn and Dunn have developed the *Productivity Environmental Preference Survey (PEPS)* [4] which incorporates environmental, perceptual, and sociological preferences. The *PEPS* test, a 100-item, 5-point Likert scale, evaluation, breaks from the traditional either/or classification of type, instead reporting a level of compatibility with a particular style. Compatibility with seemingly contradictory styles is possible. For example, an individual may have a high compatibility with a group learning environment as well as an individual environment. Relevant perceptual elements include auditory, tactile and verbal kinesthetic, and visual picture. Preferences for group or individual, tactile or verbal envirnoments might have important ramifications in a group-based introductory physics course.

Rundle's *Building Excellence (BE)* exam [19] is similar to the *PEPS* test. It is an 111-item questionnaire that uses a 5-point Likert scale. It expands the social dimension to include small teams of 2-3 people, as opposed to just individual or group preferences. In addition, it can be administered online.

Correlating Course Grade with *LSP*

The *Building Excellence* exam was administered to 390 students enrolled in the first quarter of RIT's

	Fall 2002		Winter 2002-3	
	SCALE-UP	Lecture	SCALE-UP	Lecture
N	55	43	41	251
$< G >$	3.44	3.48	2.43	2.84

TABLE I: Average course grades $< G >$ for students who took the *Building Excellence* survey.

	SCALE-UP			Traditional		
	Alone	Group	Team	Alone	Group	Team
%	80	53	51	77	55	55
$< G >$	2.37	2.37	2.30	2.92	2.97	2.91

TABLE II: Average grade $< G >$ for students expressing compatibility with individual, group, or team environments. No correlation between performance and preference is seen. Students with a strong preference for individual environments do not fare worse in the SCALE-UP environment, where group work is common.

	SCALE-UP			Traditional		
	Auditory	Neut.	Low	Auditory	Neut.	Low
%	28	40	31	38	38	23
$< G >$	2.44	2.35	2.41	2.99	3.03	2.69

TABLE III: Average grade for students expressing a strong, neutral, and low preference for auditory learning. The under-performance of low-auditory learners in traditional settings is not statistically significant ($p = 0.1$).

three-quarter calculus-based introductory physics course. 98 students participated in the fall of 2002 and 292 participated in the winter of 2002-2003. The test was administered on-line, so students could take it at their convenience and it did not detract from class time, although all students that took the test did so within the first 2 weeks of class. We have not investigated whether the classroom activities can influence student response on Learning Style assessments; such a study would be quite interesting. A breakdown of student performance is shown in Table I. The average class grade was the same in the fall quarter, but students in the traditional sections in the winter had a higher average grade (2.84 to 2.43). Our current analysis looks for differences between students in similar environments, so this difference is not a problem. In order to compare performance between students in different environments we compare the deviation from mean section grade. This seems to remove the artifact caused by the different average grade of different sections.

Social Environment

The *BE* test gauges compatibility with three different sociological styles, alone/pairs, small groups (3-4 students), or in teams (4 or more). Table II, combining students from the fall and winter quarters, shows that there was little difference in final class grade in either SCALE-UP or traditional sections. We hypothesize that students mold their environment to match their preferences. Students in traditional classes who prefer group interactions might satisfy this need by formin study groups. Similarly, students in SCALE-UP classes who prefer individual learning might find a niche within their group.

Auditory Learning

Of particular interest to many faculty are auditory learners, or those who claim to learn best by listening. Unlike the social dimension, the auditory dimension is exclusive; learners have either high, neutral, or low aptitudes for auditory environments. We looked for a depressed average grade in high-auditory learners in SCALE-UP classes and the converse in traditional classes. As table III shows, however, there is no apparent correlation between auditory preference and grade. There may be some self-selection here, as those with a preference for auditory environments may choose traditional sections over SCALE-UP sections. The data, however, show little benefit from this choice.

Little correlation was found between course grades and any preference as expressed on the *Building Excellence* exam. There are several possible explanations for this. The final course grade may be too coarse a measurement of learning to distinguish this effect. Student preferences may not, in fact, align with the environment that best produces learning (consistent with [6]). Finally, students may find ways to apply their particular learning styles regardless of course structure.

Student Interviews

The ability of students with strongly expressed preferences against group learning appeared to succeed in the seemingly discordant SCALE-UP environment. One student, in particular, had an interesting combination of *LSP*s and agreed to be interviewed several times throughout the quarter. "Max's" *BE* scores indicated a low compatibility for learning in small groups, an aversion to auditory learning, and a strong dislike for for authority-driven methods. In class, Max's ostensible participation was very limited, and frequently his partners would turn and talk amongst themselves, leaving Max on the periphery. At the same time, his perceptual *LSP* dimensions classified Max as one who is internal and tactile kinesthetic, meaning he learns by verbalizing to himself or to others and needs to be actively doing something. This tactile kinesthetic need may or may not be specific to the task, and Max was often seen doodling, which may have satisfied this need.

Max strongly preferred the SCALE-UP classroom to the traditional one (he had dropped out of a previous traditional class), saying

> I learn a lot better with hands-on and group activities. As we got into the class, I realized that I understood things a lot better, and I didn't know why. I kind of paid more attention to it and I realized that we were explaining stuff to each other and teaching each other.

Max rarely spoke out in class, but saw himself participating in his group although, as noted, his group did not share this view. Max included himself when describing group activities with statements like "Here's where we are measuring the force...", "We're all interacting, doing the same thing...", or "We're solving problems...".

Max maintained an above average grade (B) throughout the quarter, falling at the end to a high C. His *FMCE* post-test score of 60% was at the class average (Max did not take the pre-test so no normalized gain can be calculated). Especially when compared with his experience with lecture-based course (he withdrew), Max's story in SCALE-UP can be considered a success despite the extreme mis-match between expressed preference and environment.

Isolating Learning Style Dimensions

As many research-based curricula [7, 8, 9] have reported significant learning gains, often attributed in part to the group work, the question of learning styles vis a vis group interactions is important. Specifically, are there students who learn best individually and, if so, how do they fare in group activities? A related question involves the stronger students. A common fear amongst faculty skeptical of group work is that the stronger students in a group will carry along their less capable partners. Work by Beichner [13] and others has shown that in fact stronger students benefit most from the new activities, and a plausible explanation is that the process of explaining ideas to partners actually helps learning (along the idea that one doesn't learn until one teaches). The proof, however, is rather indirect. It is not clear whether the student learning is improved because of the group activities or from the research-based activities all students are asked to perform.

Methodology

Student volunteers were solicited and paid to spend two hours working through activities and taking various *LSP* assessments. Students were required either to have taken introductory calculus-based physics in the previous 2 years or to be currently enrolled in the course. After a short pre-test, students spent approximately 40 minutes on each of two activities. A post-test concluded the session. In the first hour, half of the students worked on a worksheet in groups of three while the other half worked on the same worksheet alone. In the second hour, the groups switched. To reduce the chance that students would be familiar with the topics, we chose activities involving buoyancy, a topic typically outside the typical introductory physics curriculum. Related activities included hydrostatics, which research has shown students to struggle with. Activities had been developed as part of the *Explorations in Physics* [20] curriculum and were adapted for this research.

The pre-test incorporated those questions from the *Building Excellence* survey which probed the social dimension, and assessed student preferences for group or individual activities. Students were also given the Keirsey Temperament Sorter, a 70-item questionnaire, to assess personality types. Pre- and post-content tests were devised and tested on 1st-year physics majors who were not participating in the study. This test confirmed that the topics chosen were at the appropriate level but also commonly misunderstood.

Students were randomly divided into groups of 12. Of these, 6 students worked on an activity alone, and 6 were split into groups of 3. After working on an activity for 45 minutes, the groups of 12 switched lab rooms. Those that first worked individually now worked in a small group, and those who first worked in a small group, now worked individually. The activity guide contained 2-3 self-contained experiments that students could perform with little prior preparation. Students were asked to make predictions, record data, posit explanations and imagine applications for the ideas they develop. Students were asked to record complete answers whether they worked alone or in a group. When they had spent 45 minutes on each of the two topics, students were then given a post-test.

Preliminary Results As with the previous study involving course grades, little correlation between personality types, sociological learning style preference and performance on pre- and post-tests were found. We offer some possible explanations for this lack of correlation, recognizing that there may be many more. Possible explanations include,

- the expressed learning style preference may bear little connection with the environment in which the student best learns
- college students may effectively activate other learning resources when placed in a less preferred environment
- activities might need to be refined to fit within the alloted forty-five minutes, or the chosen topics may be inappropriate
- pre- and post-tests are too coarse to measure improvement in student understanding
- 8am on a Saturday morning may be too early to start any study involving college students

Summary

Learning and the educational setting is a very complicated balance of learning styles, teaching styles, personality types, environmental factors, innate physiological and psychological factors, motivation, socioeconomic backgrounds, culture, and numerous other factors that may effect the learner. While common assessments that have been validated for internal consistency do produce some discrimination between different students, there appears to be little significant correlation between learning style preference and performance (as measured by course grade) in different learning environments. This is greatly complicated by the fact that classes, extending over a ten-week quarter, expose students to many different environments. In addition, students possibly seek out-of-class environments that more closely match their preference. (This will be the subject of an upcoming study in which we will ask students about their out-of-class activities and look for correlations with their expressed *LSP*.) Attempts to isolate students in a restricted environment do not yet produce discrimination in learning, although we believe this methodology, with significant refinement, shows promise. Finally, by studying individual students with extreme preferences we may gain insight into the manner in which different students learn. Our crude analysis seems to indicate that we are not harming students by placing them in the educational setting that might not best suit their aptitudes.

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[1] R. Dunn, J. S. Beaudry, and A. Klavas, Educational Leadership **46** (1989).
[2] R. Dunn, Reading, Writing and Learning Disabilities **6** (1990).
[3] I. B. Myers, *Manual: The Myers-Briggs Type Indicator* (Consulting Psychologists Press, 1975).
[4] R. Dunn, K. Dunn, and G. E. Price. *Productivity Environmental Preference Survey: An Inventory for the Identification of Individual Adult Preferences in a Working or Learning Environment*. Price Systems, Box 1818, Lawrence, KS 66044-0067.
[5] Http://www.ncsu.edu/felder-public/ILSdir/ilsweb.html.
[6] D. Druckman and R. A. Bjork, eds., *Learning, Remembering, Believing: Enhancing Human Performance* (National Academies Press, 1994).
[7] P. Laws, *Workshop Physics Activity Guide* (John Wiley & Sons, 1999).
[8] D. R. Sokoloff and R. K. Thornton, *Interactive Lecture Demonstrations* (John Wiley & Sons, 2001).
[9] L. C. McDermott, P. S. Shaffer, and the Physics Education Group, *Tutorials in Introductory Physics* (Prentice Hall, 1998).
[10] T. Larkin, M. Feldgen, and O. Clua, presented at the IEEE/ASEE Frontiers in Education Conference, Boston, MA. 2002.
[11] T. Larkin and D. D. Budny, IEEE Transactions on Education Journal **44** (2001).
[12] R. K. Thornton and D. R. Sokoloff, American Journal of Physics **66** (1998).
[13] Www.ncsu.edu/per/SCALEUP/.
[14] H. G. Lang, M. S. Stinson, F. Kavanagh, Y. Y. Liu, and M. L. Basile, Journal of Deaf Studies and Deaf Education (1999).
[15] R. M. Felder and L. K. Silverman, Engineering Education **78** (1988).
[16] R. M. Felder, G. N. Felder, and E. J. Dietz, Journal of Engineering Education **91** (2002).
[17] L. McCullough and D. Meltzer, in *Proceedings of the 2001 Physics Education Research Conference*, edited by S. V. Franklin, J. Marx, and K. Cummings (American Association of Physics Teachers, 2001).
[18] L. McCullough and D. Meltzer (American Association of Physics Teachers, 2002).
[19] Susan M. Rundle with Rita Dunn, *Building Excellence Survey*. 2002. Performance Concepts International, 585-383-9086, ww.pcilearn.com.
[20] D. P. Jackson, P. W. Laws, and S. V. Franklin, *Explorations in Physics: An Activity-Based Approach to Understanding the World* (John Wiley & Sons, 2002).