Student Perspective on an Online Asynchronous Introduction to Linux based on User-First Pedagogy

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ABSTRACT
An introduction to Linux is used to survey students' perception of required effort levels, suitability of tools, pedagogies of contents / instruction. Their perception of the relevance of various cognitive skills taught, along with their evaluation of how well the teaching material supports their acquisition, supplements previous findings on the educational nature of an introduction to Linux.

Survey results are interpreted in terms of the impact on student's motivation of the misalignment of their perceptions about the relevance of specific cognitive skills with both academic & industry perspectives. We also review what results teach us on the appropriateness of both pedagogies of contents & instruction. We then discuss observations which highlight potential issues but require further specific studies to allow us to design interventions to address them.

Categories and Subject Descriptors
K.3.2 [**Computers and Education]**: Computer and Information Science Education – *computer science education, curriculum.*

General Terms
Measurement, Human Factors.

Keywords
Linux, online learning, Bloom Taxonomy, attitude surveys.

1. INTRODUCTION

1.1 Motivation & Previous Work
Computing education researchers have devoted significant efforts investigating the learning barriers encountered by undergraduates in both introductory – e.g. CS0 – and programming offerings.

Proportionally, significantly less work has been devoted to studying such barriers in system administration offerings despite their relevance to Information Technology. The Bloom taxonomies' **[2][3]** relevance to computing education has already been suggested by multiple studies focused on undergraduate programming pedagogy; see **[3-8]** for examples.

The application of the Revised Bloom's Taxonomy to an introduction to Linux system administration, revealed that the cognitive skills required from students on graded assignments, along with those desired by their future employers, spread over a spectrum similar to that of programming activities **[9-12]**.

1.2 Objectives
Students' appreciation of higher order skills was found to be sometimes at odds with both academic & industry perspectives **[10]**. This motivated a more detailed study of the student perspective on various aspects of an introduction to Linux. We use an online anonymous survey to better understand students' attitude with respect to; the suitability of tools, the required effort levels, the pedagogy of contents / instruction, the value of skills being taught & efficacy of the teaching methods.

1.3 Organization
Section 2 establishes the context of this study; specificities of our offering, student population's characteristics, detailed pedagogy of contents & of instruction used. Section 3 discusses how our attitude survey captured the student perspective on the tools we used, required effort level, pedagogies of content & instructions, & their relevance to an established educational taxonomy. Section 4 presents survey results while section 5 discusses them.

2. BACKGROUND

2.1 User-Level Intro to Linux
The main innovation of "User Level Intro to Linux", aka ULIL, is to not start with system administration topics but, instead, aim at preparing IT students for working in a Linux environment as developers, web designers…. The focus is roughly equivalent to that of CompTIA Linux+ certification exam LX0-101.

This strategy has so far attracted a broader range of students, including non IT majors. Informal feedback underlined its relevance to prepare students for upper-level offerings which require them to work with Linux; e.g. IT Networks, IT Security.

ULIL is taught over 15 weeks as an online asynchronous offering. As such, there is no mandatory class meeting. Videos & assignments are made available via a Learning Management System – LMS – also used to turn in assignments. Students meet the TA & instructor using "Blackboard Collaborate" web-conferencing software. These sessions are one-on-one or with small groups. Formative feedback is provided to students for every weekly assignment & exams. Quiz solutions are released after their respective deadline. Non-graded material is available at http://cereal.forest.usf.edu/linux/L1/.

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2.2 Student Population

Students are Junior-standing undergraduates who are not necessarily majoring in Information Technology. Additional demographic information gathered in fall 2011 & spring 2013 revealed that the average student is 30 years old, employed 26 hours every week, enrolled in 3 other 3-credit courses & spent about 4.5 years employed in IT. Out of the 34 respondents, 85% (29) were males, and15% (5) were females.

Assuming 12 hours of work per week for every 3-credit course, these students have committed to 48 hours of academic workload on top of being employed on average 26 hours per week. The label "overcommitted adult learner" has been used by our team to describe such students. There is high pressure on them to spend as little time as possible on each course. From an instructional perspective, this exacerbates compliant learner tendencies, e.g. "no time to try ungraded exercises", "no time to just explore this topic if it's not on the exam". These are detrimental to the acquisition of a long-term education vs. a short-term training.

It is essential to keep the characteristics of our student population in mind throughout this paper. First, it will explain some of the pedagogical design decisions; e.g. weekly assignments worth a few points. Second, they will allow the reader to interpret our findings in the specific context from which they arose.

2.3 Tools

Students' learning, along with their overall interest in working with Linux, might be hindered by the use of poor tools.

ULIL requires students to work on *Ubuntu Desktop LTS 12.04*. A desktop version was selected to enable us to teach both command line interface tools – CLI – & graphic user interface usage – GUI. Since most students come from Windows or Mac environments, it is expected they will do better in a user-friendly desktop as they progressively learn CLI tools. We favored the Long Term Support edition in order to prevent the need for the instructor to re-record videos featuring GUI elements every semester.

Similarly, students are required to use Virtual Box. Its availability on any platform allows students to keep their preferred OS while working on easy to snapshot / restore virtual Linux images.

2.4 Pedagogy of Contents

Whereas pedagogy of instruction is concerned with how the subject matter is taught, pedagogy of content is focused on which specific topics are taught and in what order. An example of this would be the object first versus fundamentals first dilemma in programming pedagogy.

Table 1 – Topics taught in User-Level Intro to Linux

#	Topic	#	Topic
1	*Using Virtual Box*	*9*	*Other Distributions*
2	*Installing Ubuntu*	*10*	*Shell Initialization*
3	*Ubuntu Desktop*	*11*	*Redirections*
4	*Linux Terminals*	*12*	*Filters*
5	*Getting Help*	*13*	*Regular Expressions*
6	*Software Packages*	*14*	*File System*
7	*Shell Quoting*	*15*	*Processes*
8	*User Management*		

ULIL's pedagogy of contents diverges from Linux system administration introductions. Our focus is on fostering a deep understanding of the tools available on Linux platforms.

Table 1 lists the topics taught. Most leverage reading assignments from the textbook **[1]**. Others are presented with videos or hands-on "exploration" assignments.

2.5 Pedagogies of Instruction

ULIL is delivered as an online asynchronous offering; i.e. no mandatory weekly class meetings, either face-to-face or online. Students appreciate this flexibility due to being full-time employees already, or being geographically unable to attend face-to-face sessions; e.g. deployed military personnel.

Every Monday, one of the 12 online modules is released. Assignments are due the following Monday. This regularity has proven essential to keep students engaged & prevent them from falling behind. "Skipping a week" results in losing enough points to deter students, while not irreparably damaging their grade.

Each module covers one or more topics listed in **Table 1**. Textbook reading assignments & videos provide students with a lecture-like passive learning experience. A "support" forum is available for students to post questions anytime.

We observed that students often find themselves unable to understand what it is they are missing in such "lectures". To remedy this, **PQ** – Practice Quizzes – are provided. They allow students to test their own understanding, spot topics they missed in the readings, generate questions, without grade penalty.

To ensure students' commitment to understanding this material, 30 minutes long **GQ** – graded quiz – are used. There are 12 such quizzes, worth 36% of the students' grades.

Most modules also feature a **PA** – practice assignment – for students to apply what they learned. These are meant to take most of the student's weekly study time. They guide them to go beyond the readings to explore new topics, or simply apply them in more in-depth. PAs are also meant to reinforce the students' ability to search for new information in technical references; e.g. manpages.

PAs are graded in order to motivate students to turn them in. There are 8 PAs representing 8% of the students' grade. The amount of points is kept low to not penalize explorative learning.

During the week, they are allowed to work with the instructor / TA to get help solving the PA. During these help sessions, we are careful to not provide solutions but rather identify what students misunderstand in order to provide tailored on-demand lecturing. Feedback is provided the week following the PA's submission in order to help students understand what they missed.

Three **exams** are administered over the semester. These are equivalent to a PA & represent 45% of the student's grades.

Some modules have **DF** – discussion forums – which require students to research a simple topic, post a synthesis of their readings, & read other students posts. There are 6 DFs worth 6% of the grade. Grades are mostly participation based.

Table 2 – Learning Activities used in User-Level Intro to Linux

#	Learning Activity	#	Learning Activity
1	*Reading Textbook*	6	*GQ – Graded Quiz*
2	*Watching Videos*	7	*PA – Practice Assignments*
3	*DF – Reading Posts*	8	*Exams*
4	*DF – Participating*	9	*PL – Participating*
5	*PQ – Practice Quiz*		

Forums are also used for 2 **PL** – Peer Learning – activities which require students to post a few "challenges" based on what they felt was the most difficult aspect of a module. They then attempt to solve other students' challenges. These activities are used for difficult modules, e.g. regular expressions, in order to help students revisit the material explicitly looking for the most difficult notions which are usually missed on initial readings. These two PL assignments are worth 5% of students' grades.

3. METHODS

We used an anonymous online survey hosted on Survey Monkey to gather students' attitudes & perspectives. The link to take the survey was provided to students via LMS announcement.

Participation was optional but rewarded with extra credit. In order to keep the survey anonymous, a "key" was provided on the last page of the survey. Students were invited to email it to their instructor so they would be assigned the extra points.

The last version of the survey was administrated with an option to skip to the last page in order to discourage participants from responding randomly just to get to the end of the survey.

3.1 Tools

A "rate your agreement level with the following statements" question was used to capture the students' attitude toward the usage of Virtual Box and Ubuntu. The relevant statements were;

- **T1** *Virtual Box was easy to use*
- **T2** *Virtual Box provided me with the features I needed to support my learning*
- **T3** *Ubuntu Linux was easy to use*
- **T4** *Ubuntu Linux provided me with the features I needed to support my learning*

For each statement, students were able to respond using a 5 points Likert scale labeled; "Strongly Disagree", "Disagree", "Neutral Opinion", "Agree", "Strongly Agree".

In addition, "N/A" and "Didn't use it" options were available. Only a few students reported not using virtual box in spring 2011.

3.2 Effort

We used the following question to measure the amount of efforts students perceived devoting to this offering;

- **E1** *How many hours did you spend every week working on this offering? Provide an average value, round up to the next integer.*

We also used open-ended questions to identify the learning activities perceived as most time-consuming & the hardest topics.

- **E2** *What were the most time-consuming learning activities?*
- **E3** *Which topics were the hardest to learn about?*

3.3 Pedagogy of Contents

Due to the ever-evolving nature of IT, it is often easy to not expose students to all aspects of the technology being studied. We polled students to provide feedback on the following questions;

- **PC1** *Which of the topics we studied should have been studied in more depth?*
- **PC2** *Which of the topics we studied should have been studied in less depth?*
- **PC3** *Which topics do you think were missing from this user-level intro to Linux*

For the first two questions, we mapped students' responses to the topics listed in **Table 1**. For the last question, we took note of the responses pointing to something not already taught in the material, thus removing responses such as "more GUI", "more regex"…

3.4 Pedagogy of Instruction

Question **PI-1** was formulated to indirectly identify which of the 3 following pedagogies our students preferred;

If given a choice between several good things, it's natural to want them all :) Reality is that students and instructors' time is at a premium and priorities need to be given. Assuming you have only N hours available each week to spend with your instructor. Assuming also that you have a textbook presenting the information that has to be studied this week, which of the following options would you prefer;

#1	Constructivist	*Reading the material on your own, then using the time with your instructor to have him address your questions*
#2	Instructivist	*Having the instructor lecture based on the textbook's material, then figure out what is still not understood on your own.*
#3	Constructivist hands-on	*Reading the material on your own, then using the time with your instructor to have him help you apply this knowledge to exercises.*

Option #2 is instructivist in nature & represents the traditional lecturing model. Option #1 relies on students to engage in active learning via formulating questions to the instructor. The instructor is free to then leverage constructivist pedagogies, based on students' personal learning barriers. Option #3 involves a similar approach but relies more heavily on hands-on learning; rather than asking questions about the material, students & instructors address learning barriers while engaged in a specific project.

Question **PI-2** & **PI-3** respectively focused on assessing the students' enjoyment of the various learning activities along with their perception of how much each supported their learning.

- **PI-2** *Rate the degree to which you enjoyed engaging in the following activities, regardless of their ability to support your learning.*
- **PI-3** *Rate the usefulness of the following learning activities to support your learning, regardless of how much you did or did not enjoy engaging in them. Keep in mind that different activities aim at supporting you with respect to different learning objectives e.g. technical proficiency is different than just discovering open sources possibilities.*

For both questions, students were provided with the list of learning activities outlined in **Table 2**. They were able to express their opinion using two separate 5-point Liker-scales.

- **PI-2**'s labels were "didn't enjoy at all", "didn't enjoy it much", "neutral", "enjoyed it somewhat" & "enjoyed it very much".
- **PI-3**'s labels were "not useful at all", "not really useful", "neutral", "somewhat useful", "very useful".

Last but not least, we also wanted to validate the usefulness of enforcing strict weekly deadlines in an online asynchronous offering. Question **PI-4** specifically targeted this;

- **PI-4** *It supports my learning to have assignments due every week rather than being left to structure my own learning over several weeks in between graded exams*

Students were invited to rate their agreement with the above-statement using a 5-points Likert-Scale with labels "Strongly Disagree", "Disagree", "Neutral", "Agree", "Strongly Agree".

3.5 Bloom Taxonomy Levels

Previous work established the academic, industry, and student perspectives on the relevance of the Revised Bloom Taxonomy – RBT – levels to Linux system administration education **[9][12]**.

Our first question, **RBT-1**, was used to assess our students' attitude toward the relevance of these higher-order skills;

- **RBT-1** *Indicate how important you see the following cognitive skills for someone working as a Linux system administrator;*
  - *Remembering technical knowledge*
  - *Remembering conceptual knowledge*
  - *Applying procedural knowledge*
  - *Evaluating or validating alternative solutions*
  - *Troubleshooting*

Responses were on a 3-point Likert Scale with labels "useless", "somewhat important", "very important".

Next, we sought to establish the students' perspective on how well our interventions supported the acquisition of such higher level skills. They were asked to respond to the following question;

RBT-2 *Indicate how much the learning activities in this offering helped you develop the following skills;*
<list of skills follows>

The response was provided on a 3-point Likert-Scale with labels "no learning activities helped me develop this skill", "few did", "many did". These items were phrased to be directly relevant to the learning outcomes. They map to the skills, "remembering", "applying", "evaluating", "analyze", "synthesize" RBT levels **[3]**.

4. OBSERVATIONS

4.1 Tools

For the purpose of identifying the overall students' attitudes, we grouped responses falling into "Strongly Disagree" & "Disagree" groups vs. those falling into "Strongly Agree" & "Agree" groups. We labeled these respectively "disagree" & "agree" below.

Table 3 – Student Perspective on Ubuntu & Virtual Box

Q	Not used	Disagree	Neutral	Agree	N
T1	12%(6)	6%(3)	6%(3)	78%(41)	50
T2	12%(6)	6%(3)	8%(4)	76%(40)	50
T3		4%(2)	4%(2)	93%(49)	50
T4			4%(2)	97%(50)	49

Responses show strong agreement with statements about "ease of use" (T1), and "learning support" (T2), for virtual box. Agreement is even stronger for analog questions about Ubuntu (T3, T4).

4.2 Effort

A total of 48 responses were reviewed for question E1, providing an average of 9 hours per week devoted to this offering. The minimum was 2 hours & the maximum 25. An outlier who responded 80 hours per week during fall 2011 was removed since he/she also reported a 50 hours a week employment while being enrolled in 2 more offerings. This strongly suggested a typo.

A total of 44 responses were reviewed for question E2. Responses were matched to a specific learning activity; e.g. "hands-on exercises" would be matched to our PAs. Responses which could not be matched, e.g. "homework", or which focused on a topic rather than a learning activity, e.g. "regexp", were removed.

Results show that the PAs are the primary focus for students' time as they are mentioned in 63% (30) of responses. Reading the assigned textbook sections is second, mentioned in 42% (20) of responses. Forums-based activities, mostly the two peer learning exercises, are the third most mentioned with 5% (2).

Table 4 – Student Perspective on Most Difficult Topics

Topic	2011 only	2011 & 2013
Bash Scripting	49%(17)	38%(17)
Regular Expressions	32%(11)	40%(18)
Bash Init. Files	9%(3)	7%(3)
# respondents	35	45

Question E3 was influenced by the fact this offering was modified during the spring 2013 semester. Bash scripting was introduced in a one week module during the first two times the course was offered; however this topic was moved to another course to make more room for the extension of other topics. As a result, **Table 4** lists the most often mentioned topics with their frequency first during both 2011 semesters, then during spring 2013.

4.3 Pedagogy of Contents

Table 5 lists the most mentioned topics for questions **PC-1** & **PC-2**; i.e. topics which students felt should have been studied in more depth & the ones they felt should have been studied in less depth. The total number of respondents was 45 for **PC-1**, 40 for **PC-2**. This is for all three semesters.

Table 5 – Student Perspective on Contents

PC-1 more depth	Frequency N=45	PC-2 less depth	Frequency N=40
Bash Scripting	32%(14)	*File Systems*	15%(6)
Regular Exp.	13%(6)	*Regular Exp.*	8%(3)
Users / Groups	7%(3)	*Bash Scripting*	5%(2)
File systems	5%(2)	*GUI*	5%(2)

For question **PC-3**, 38 students provided suggestions. We removed the ones overlapping with already taught topics or mentions that the offering was already balanced as is.

The remaining suggestions indicated that some students felt that more system administration would be relevant; e.g. network configuration / monitoring, troubleshooting, mounting drives from windows systems & other basic system administration operations.

However, there was no consensus. Many students opposed these suggestions, mentioning they would prefer reducing the command line aspects to remain at a more user-friendly GUI level.

Other students mentioned a bit more involved user-level tasks; e.g. setting SSH private / public key pairs, using Emacs / Vi.

4.4 Pedagogy of Instruction

Table 6 shows responses for **PI-1**; over 50% of students favor a constructivist hands-on pedagogy. The results are rather split between the two other pedagogies thus suggesting that students do not perceive the traditional lecture model as inherently inefficient.

Table 6 – Student Perspective on Pedagogy Preferences

Options		Frequency
#1	*constructivist / active learning / questions*	23%(12)
#2	*instructivist*	25%(13)
#3	*constructivist / active learning / hands-on*	53%(28)

Questions **PI-2** / **PI-3** were used with the full list of learning activities only during fall 2011 then spring 2013. Responses are summarized in **Table 7**. We assigned integer values 0 to 4 to each Likert-scale item, starting with "Strongly Disagree". We then averaged this "rating" for each learning activity.

Table 7 presents these average ratings along with how each activity ranks; #1 being highest rating. Reading assignments were perceived as both the most enjoyable & relevant activities.

From the usefulness perspective, students then valued the remaining activities in a manner which seems proportional to how many points they were worth; exams / graded assignments first, then practice assignments, then graded quizzes, then the non-graded "practice quizzes" / study guides.

From the enjoyment perspective, students were not quite as easy to interpret. Results suggest that forum-based activities were among the least enjoyable, e.g. PL / DF, while the reading assignments, graded assignments, practice quizzes ranked highly.

Average for enjoyment / usefulness are respectively 2.36 / 3.02 suggesting that students, despite not necessarily enjoying the activities, were able to recognize their relevance.

We grouped agreement and disagreement responses to question **PI-4**, as we did in **section 4.1**.The results suggest that the majority

of students 81% (43) agreed with this approach, 12% (6) were neutral, only 8% (4) disagreed out of 53 respondents. These results confirm the benefits of regular, small value, graded assignments in online asynchronous offerings.

Table 7 – Student Perspective on Learning Activities

Learning Activity	PI-2 Enjoyment		PI-3 Usefulness	
	rating	rank	rating	rank
Reading Textbook	2.76	First	3.71	First
Watching Videos	2.65	#2	2.76	#6
DF – Reading	2.12	#7	2.35	Last
DF – Participating	2.21	#5	2.53	#7
Quiz –Practice	2.52	#3	3.12	#5
Quiz – Graded	2.15	#6	3.26	#4
Practice Assignments	2.32	#4	3.48	#3
Graded Assignments	2.62	#2	3.56	#2
PL – Participating	1.94	Last	2.38	#8
Average Ratings	2.36		3.02	

4.5 Bloom Taxonomy Levels

Table 8 shows **RBT-1** responses. Based on the number of "Very Important" ratings, troubleshooting ranks first, followed by remembering conceptual knowledge. Applying procedural knowledge is third, followed by remembering technical knowledge & evaluating / validating alternative solutions.

It is interesting to compare this ranking to the ranking, established in a previous study **[10]**, of the relevance of Linux introduction's learning outcomes by educators, industry partners, and students.

Three of the above learning activities map exactly to learning outcomes from **[10]**; "Apply procedural" maps to "SK1 – following procedures", "Evaluate / Validate" maps to "SK4" & "Troubleshooting" maps to "SK5". Our ranking confirms the students' ranking in **[10]**. Therefore, the same observations regarding the misalignment of the perceptions expressed by students vs. industry partners vs. educators also apply here.

In both studies, troubleshooting is top ranked by students. Educators ranked it 3rd out of 4 in terms of cognitive difficulty while surveyed industry partners ranked it 3rd based on relevance. Applying procedural knowledge is similarly top ranked by students while it is ranked last by both educators & industry. Comparatively, surveyed industry partners ranked higher the ability to evaluate critically alternative solutions to a given problem. This skill, while ranked similarly by students & industry partners alike in a previous study **[10]**, appears here as the least important for our students.

Alignment of the educator / industry perspectives is necessary to ensure students are taught relevant skills. Alignment of the student / industry perspectives is necessary to ensure proper motivation.

Table 8 – Student Perspective on higher-skills relevance

Learning Activity	Useless	Somewhat important	Very important
Remember Technical	0%(0)	28%(9)	73%(24)
Remember Conceptual	0%(0)	16%(5)	85%(28)
Apply Procedural	0%(0)	22%(7)	79%(26)
Evaluate / Validate	3%(1)	28%(9)	70%(23)
Troubleshoot issues	6%(2)	6%(2)	88%(29)

Table 9 shows the responses provided by students to question **RBT-2**. Results suggest that learning activities are perceived as supportive of the acquisition of lower-level cognitive skills, e.g. remembering & applying. There is a significant drop in the number of students feeling that they were supportive of the development of evaluation & troubleshooting skills.

Table 9 – Student Perspective on higher-skills support

Learning Activity	None	Few	many
Remember Technical	0%(0)	39%(20)	62%(32)
Remember Conceptual	0%(0)	33%(17)	68%(35)
Apply Procedural Knowledge	0%(0)	31%(16)	70%(36)
Evaluate / Validate Solutions	4%(2)	43%(22)	54%(28)
Troubleshoot issues	13%(7)	45%(23)	43%(22)

5. DISCUSSION & FURTHER WORK

This section proposes interpretations for the results presented. Hypotheses are formulated & future research efforts outlined.

5.1 Improving Motivation

Rankings of Bloom levels, based on **Table 8**'s "very important" ratings, confirm the student's perspective on the relevance of their corresponding learning outcomes as published in **[10]**. Given the difference in pedagogies of contents & instruction between the introductions to Linux used in this study and **[10]**, these results should reflect students' attitudes on Linux technologies in general.

The fact that student view "evaluating / validating alternative solutions" as being the least important skill to develop, needs to be addressed. This is especially true since they see other moderately important skills, e.g. "troubleshooting" / "apply procedural knowledge", as more important contrary to industry's perspective. Addressing this misalignment is essential to motivate students; skills which are both difficult to learn and perceived as not useful are generally under-studied.

In addition, we believe that such misperceptions may have a long-term insidious impact on the quality of the educational process. A student receiving poor grades on learning outcomes which he or she deems irrelevant is more likely to provide negative feedback. This feedback is blind to the pedagogy of contents, instruction or even their long-term positive impact. As such, it might discourage instructors from persevering in providing appropriate preparation. This is especially plausible in institutions which base teaching evaluations on superficial measures of "customer satisfaction".

5.2 Supporting Learning

Results in **Table 7** suggest that students' perceived usefulness of learning activities is proportional to the points assigned. Such results corroborate the hypothesis that, given limited time to work on offerings every week, our specific student population reverts to compliant-learner behaviors. This result motivates further studies along two paths;

1. Establishing, through a multi-institutional study in various IT departments, whether such perceptions exist among full-time students
2. Establishing the industry perspective on the usefulness of our learning activities in order to rule out the possibility of a coincidental situation whereby the point value indeed matches both industry & students perceptions of usefulness.

These results might also simply show the need for more efforts in explaining the relevance of low-ranked learning activities. Establishing whether we are dealing with a side-effect of the "overcommitted adult learners" profile will be our next priority.

5.3 Teaching Strategies

Table 6 suggests that, students prefer hands-on constructivism, but do not prefer other forms of constructivism over instructivism.

This is in stark contrast with computing education research literature which seems to favor constructivism & active learning.

Additional feedback left by students in open ended questions suggests that their affinity for a lecture model might be due to difficulties with reading assignments. While grades show that the material is not trivial, students do not post or email questions about their readings. This hypothesis is also supported by the success of reading comprehension remedial interventions on marketing students from the same campus **[13]**.

If proven valid, this hypothesis might shed new light on the reasons behind students' appreciation for lectures. Using those to summarize readings might not be the best pedagogical approach, see **Table 6**, but it might be perceived as necessary to remediate difficulties in acquiring baseline knowledge from written material.

This hypothesis also suggests that developing remedial reading comprehension activities, adapted to IT students' needs, might be much more beneficial than lectures or videos allowing them to bypass acquiring skills which are essential to any IT professional.

5.4 ULIL pedagogy

Results in **Table 3** suggest that the use of Virtual Box & Ubuntu was suitable both in terms of learning support & ease of use.

While no consensus was reached on the pedagogy of content, no major problem was identified. Effort level & list of most demanding topics align with expectations; see **Table 4**.

From the pedagogy of instruction perspective, efforts need to be invested in making the social activities, e.g. forum-based, more enjoyable; see **Table 7**. This might be a challenge if our students are indeed compliant learners since the notion of an enjoyable learning activity is almost incompatible with investing only the minimal time needed to achieve passing grades. In such situations, increasing the points rewarded or making requirements more explicit – e.g. "Your forum post should be at least 200 words long" – only further refines the parameters to which students will comply without necessarily fostering genuine engagement.

Last but not least, the relevance of a "user-level first" introduction to Linux vs. a traditional system administration introduction, is more difficult to establish without students taking both. However, a few students mentioned, in unsolicited email feedback, that they found this offering useful to prepare them for subsequent IT offerings which require working with Linux; e.g. IT Networks, IT Operating Systems, IT Security… For such endeavors, a system administration focused version might not be as directly relevant.

In addition, during spring 2013, students were offered opportunities to take free certification exams. About a third of students, 7 out of 22, expressed interest. The majority of our students, 15 out of 22, therefore match our target audience; i.e. no interest in specializing past this offering in system administration.

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