**Digital Socrates: A System for Disseminating and Evaluating Best Practices in Education**

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Abstract

Higher education is not effectively incorporating new discoveries in cognitive science and human learning into effective teaching strategies. In this paper, we explore the various impediments to change. To partially overcome these barriers, Drexel University, in collaboration with Untra Academic Management Solutions, LLC, has embarked on the development of a knowledge management system to assist instructors in obtaining, implementing, evaluating and disseminating new educational innovations. The system as envisioned would be capable of adapting to various educational environments and evolving with changes in curricula, faculty expectations, learning outcomes and student characteristics. What we are proposing is not a specific learning innovation per se but rather a systematic methodology of delivering educational innovations in the right amount, in the right place and at the right time.

**1. Introduction**

Teaching styles in higher education have undergone little fundamental change despite considerable research into education and human learning 6,19,20,22,35,36. Among the conditions that impede the implementation of new innovations are following:

1. ***Lack of faculty interest in educational innovations***31
2. ***A culture in higher education either passively or actively hostile to change***11,19,22,27,31, 33,35
3. ***Faculty who teach mainly in isolation and thus have little or no opportunity to disseminate innovations through inter-personal contact***28
4. ***Limited resources at both a personal and institutional level which could be dedicated to improved teaching***19,28,33
5. ***A mismatch between innovations and faculty developed course goals***19,28
6. ***Inadequate information on the innovation, its underlying principles and historical***

***context***13,19,28

1. ***Issues related to the return on investment (ROI) for the time and resources needed to implement an innovation***20,28
2. ***Poor design both of the innovation itself and the mode of dissemination***6,10,12,19,20,36,37

These issues are far from trivial. Studies point to a growing disparity between what college graduates know and what they should know in order to be ready for work in the new global economy2,4,5,18,22,26. Higher education appears to be failing to prepare students for future work expectations and challenges.

At the same time, colleges and universities must deal with a significant paradigm shift in the meaning and practice of education in the new information age. Before the Internet, colleges and universities could rely on being the sole viable source of complex information for the general public. If a student wished to learn about molecular biology or art history or civil engineering, he or she had no other option but to participate in the college experience – other publicly available sources were severely limited and virtually inaccessible. Combined with the emphasis placed on science and engineering during the Cold War era and the explosion of information related to the academic disciplines, these circumstances allowed university faculty to shift from teaching to information delivery as the primary method of interacting with students. Information delivery is far less time-consuming and labor-intensive than teaching and this allowed university faculty to shift their focus from teaching to research and other scholarly activity.

This shift in emphasis has become a trap from which college and university faculty are finding it difficult to escape. The ever-growing emphasis on scholarly activity, and especially funded research, continues to erode the time and resources available for interaction with students. Students, moreover, are no longer dependent upon institutions of higher education for information. The Internet provides vast amounts of information with minimal investment. Faced with two sources of information – the nearly free Internet characterized by rapid responding search engines apparently able to answer any question versus an expensive and slow university system with distant faculty having limited resources with which to respond – students may well question the ROI of a university education. Thus, at the very time when there is a significant justification and reason for shifting back to real teaching from mere information delivery, research-driven university faculty are being hard pressed to find the time and resources to make that shift.

Another significant factor is the ever-accelerating rate of technological and cultural change. In previous decades, faculty could design curricula with a reasonable expectation of what incoming freshman could expect when they graduated as seniors. This is no longer the case and this creates a new pressure to shift from current focus on knowledge-building to the development of flexible and adaptable workplace skills. In this scenario, knowledge-building is no longer an end in itself but becomes a vehicle for the acquisition of higher-order cognitive skills22.

A number of recommendations have been made to improve dissemination and integration of educational innovations, such as:

1. ***Match the educational innovation to the instructor’s learning goals***10-13,19,20,22,28.Most researchers contend that the educational process should drive specific innovations – in other words, the innovation needs to solve a real problem as perceived by the instructor. An auxiliary recommendation is to embed the innovation into current practice rather than attempt to revise everything at once8,13. Thus, change should be gradual28 or as one researcher put it – the ‘right size byte’ 32;
2. ***Educational innovations should be flexible and able to be adapted to local conditions***10,12,19. Douthwaite and colleagues10 argue for simple innovations in order to provide for easy revision.
3. ***A means or method should be provided to experiment and reflect on the results of applying any innovation***12,17,22,36 . Fullen17 and Wolff36 contend that teachers must act as learners themselves and fully participate as partners in any revision of the educational process.
4. ***To support such reflection, instructors should be provided with educational research and ideas as well as the finished product***12,19. To do this, Englert and colleagues12 recommend providing the principles underlying an innovation as well as the historical context in which the innovation developed.
5. ***Innovation must be supported*** 22,28. No system of educational enhancement is very likely to succeed if not supported by the administration and faculty of the institution.

We believe that two main factors underlie many of these issues: an inaccurate and inappropriate model for dissemination and a disparity between educational research and classroom experience.

Current dissemination practices for education appear to be based upon the transfer of technology

model10 in which the basic flow is unidirectional from research generated by scientists/engineers to fully developed product to adoption by stakeholders. When similar approaches were used in software development, so many failures were generated that a new iterative approach – the Rational Unified Process (RUP) – involving user feedback at multiple stages - was developed21,23. Douthwaite and colleagues10 contend that similar mechanisms operate during the successful adoption of innovations in general and would thus apply to educational improvements.

Henderson and Dancy19 created an adoption model for educational innovations based upon a continuum with Adoption (a ‘one-size fits all’ methodology created by educational researchers to be implemented without any significant modification) at one extreme and Invention (instructors generate their own methods and consider educational research results to be essentially irrelevant) at the other. Adaptation and Reinvention lie between these extremes and provide for user feedback and modification which Henderson and Dancy19 argue are critical elements in the acceptance of new educational approaches.

The very nature of standard research practices may also serve to inhibit implementation of new educational approaches. The underlying assumption in most research is that the samples used in experiments are representative of the target populations. In the case of educational research, students are the target population. For inferences to be valid, the samples must be selected in such a way as to randomly sample all students, regardless of background, motivation, socioeconomic status, etc. Seldom, if ever, do samples of students actually meet the rigorous standards required. Even if they did, student populations change from generation to generation, rendering conclusions obtained at one time potentially invalid for subsequent student populations. Finally, statistical approaches typically look for average differences or mean effects – individual variation is deliberately hidden or controlled. Faced varied, diverse and ever-changing student populations filled with individual differences, standard statistical approaches fail to provide the kind of analyses needed to support modular applications of educational ideas.

**2. The Learning/Dissemination Model**

To effectively deal with these issues, we propose the use of a learning dissemination model combining Douthwaite and colleagues10 Learning Selection Theory and the theory of memetic evolution first suggested by Dawkins7 and elaborated by Sterelny34.

In Douthwaite, et al.’s10 analysis, the acceptance and dissemination of innovations takes place as a cultural version of natural selection. In their view, there are three steps in the process:

1. **Novelty *generation***;
2. ***Selection* of Beneficial Novelties**;
3. ***Promulgation* and Diffusion of Novelties via a *Social Network***

In this view, scientists and engineers do not create final products but rather promising prototypes (‘best bet’ prototypes) which are then tested in the field. The best prototypes are selected based upon performance. Feedback from users leads to modifications in the prototypes which are then retested, selected, modified, etc. in an ongoing process of variation and selection. This approach bears a striking similarity to the RUP created for software development.

One limitation in this approach is that the possible propagation of incorrect or invalid ideas is not considered. Memetic evolution is another model based upon gene-centered theories of evolution by natural selection7. A meme is a self-propagating unit of information whose success is based solely upon the copies of the information created and not upon the utility or truth of the information itself. This model has problems as well, not the least of which is that cultural information is not always copied accurately. This led Sterelny34 to suggest that memetic evolution is best applied to the cultural evolution of specific skill sets, especially those associated with simple tools, where use-centered validation is likely.

Zhang37 has argued that learning environments represent complex systems with emergent properties and evolutionary potential. She argues for two categories of change in such systems: supervenient (bottom up) causation where complex higher order properties emerge from changes in lower-level components and downward causation (top down) when the impact of system reorganization affects individual components. Given the resistance of higher education to top-down reform11,12,19,22,31,33, an evolutionary approach through component variation and evidence-based selection would seem to have the highest probability of success.

For these kinds of evolutionary processes to work, you need a unit of selection analogous to a gene or meme, variation in those units, and selection pressure or criteria. We propose creating a database – the ***EduApps Portal*** - consisting of instructional or learning elements that can act as units of selection. Variation will be supplied by instructor and/or student modification to the original elements which can be then fed back into the ***Portal*** which acts as a kind of gene (or meme) pool. Elements can be used in different ways in different courses or curricula, generating various recombinations of the learning and instructional elements. Finally, student learning outcomes and the metrics associated with them – such a performance rubrics – will serve as the selection criteria to judge the success of any given element. This creates an evolving learning ecosystem.

**3. System Components and Overall Design**

The overall system would involve 4 basic components: 1. the ***EduApps Portal*** where learning and instruction applications will be stored; 2. The ***Instructional Decision Support System*** (**IDSS**) which provides instructional applications in context to faculty instructors; 3. the ***Guided Personalized Student Learning*** (**GPSLearning**) system which provides learning applications in context to students; and 4. ***SocraticNet***, a web-based social network facilitating academic communication between faculty and students. In our learning ecosystem, the instructional and learning applications in the **Portal** are the units of selection, the **IDSS** represents the instructional ‘organisms’ and the **GPSLearning** system the learning ‘organisms’ through which the units of selection are continuously tested and modified, i.e., continually evolve, and **SocraticNet** represents the environment in which our learning evolution is taking place.

**3.1 Component One – The Instruction Decision Support System**

Drexel University is current working with Untra Academic Management Solutions, LLC using the ***AEFIS*** platform (***A***cademic ***E***valuation, ***I***ntervention and ***F***eedback ***S***ystem) to develop and implement these concepts. The initial effort has been directed towards the **IDSS**, which consist of three components:

1. ***Incoming Student/Course Profile*** (**ISCP**)
2. ***Course Rationale and History Profile*** (**CRHP**)
3. ***Evaluation Results, Notes and Recommendations*** (**ERNR**)

The three tools cited above are applied to the Syllabus Manager of ***AEFIS***. Faculty developing course content view the details within these tools to be applied to their courses’ syllabi directly. The **Incoming Student/Course Profile (ISCP)** delivers relevant student characteristics—learning styles1,9,14-16,24,25 course load, work load, lifestyle, etc. to the syllabus development process. Additionally, it provides current performance data to show achievement on performance metrics in previous courses related to the current course’s materials. With this data the **IDSS** will be able to provide suggestions for instructional approaches, to include definitions of terms (what is meant by global or visual learning, etc.) and links to possible instructional approaches through the ***EduApps Portal*** for students with such characteristics. Links will also be available to the Portal for specific instructor queries, such as how to use clickers to increase class participation or how to implement a one-minute summary. The key element is that the instructor requests information about educational approaches ***in context*** and ***in time*** of the educational process in which he or she is engaged. Nothing is imposed on the instructor but rather a query-driven support system and assessable educational modules are provided in support of his or her educational mission.

The **Course Rationale and History Profiles (CRHP)** best explains how courses fit into programs’ curricula. These profiles link pertinent course information including performance criteria and/or student learning outcomes associated with the course. More than a listing of prerequisite courses or course numbers, the **IDSS** provides information regarding students’ educational experiences prior to current class and what students can expect to encounter in courses to follow. Bringing together this data will demonstrate the value of the course by explaining how learning course material will facilitate program goals—more importantly how such course materials will facilitate student goals.

The **IDSS** is based on continuous data entry and application. The longer the system is used the stronger the evidence bank will become. As such, surveys and course evaluation data procured each term will be added to the syllabus development process. **Evaluation Results, Notes and Recommendations (ERNR)** summarize the assessment data for courses. Plus, first hand feedback from faculty and students will be shared term after term with incoming faculty instructors. Any direct measures of performance of previous students will be shared as well. This data can be grouped to demonstrate correlations with student characteristics and instructional approaches. This leads to selection of those instructional applications with the best performance as an evolutionary process.

**3.2 Component Two: The EduApps Portal**

The **EduApps Portal** as currently envisioned supports three major functions. First, by provide instructors with immediate and easy-to-use access to educational innovations in context through use of the **IDSS** we hope to enhance dissemination and integration of these innovations. Second, by providing students with modular learning aids (lessons, tutorials, simulations, etc.) in the context of the **GPSLearning** system, we hope to facilitate student learning and retention of key concepts and skill sets while simultaneously promoting life-long learning. Again, the importance of the linkage between the **EduApps Portal** and the **GPSLearning** is the ability of the system to place these modular learning aids in the context of the student’s cognitive and social development. Finally, by collecting feedback and monitoring both the use of specific EduApps and the influence of those EduApps on student performance, we can alter the probabilities associated with the EduApps recommendations to the **IDSS** and **GPSLearning** systems, thus generating an ongoing evolution of learning and instructional methodologies.

Creating an environment to better support faculty development and the adoption of innovative teaching and learning methods is a tall order. The success of these efforts is premised on two conditions – opportunity and reward – each influencing the probability of success in interconnected ways. Changing the reward structure is an administrative task and not the focus of the **IDSS** and **EduApps** project. Our concern here is opportunity. Faculty can feel trapped by the restrictions of the current lecture-based teaching model and the emphasis on research output. The time and expertise needed to develop new models of education seem beyond reach, especially to young tenure-track faculty, and even scanning the educational literature may seem too great a task. How do they choose an appropriate model? How do they know what does and does not work? What is a student learning outcome? Under such circumstances, most faculty will fall back on their own educational experiences – usually based upon the ‘sage-on-the-stage’ lecture motif – and thus perpetuate a defective model.

Drexel’s **EduApps Portal** provides a simple, efficient and effective method for faculty to disseminate and use innovations. By providing proven methodologies for specific issues, faculty can easily download and use new techniques without going through an exhaustive search of the educational literature. Using the **IDSS** platform, **EduApps** will be designed with embedded assessment tools, ensuring that evaluation and feedback are part of the approach. Again using the **IDSS** platform, specific **EduApps** can be directly linked to student characteristics. Thus, when faculty have a question related to teaching – for example, how do I educate students who are reflective learners, the instructor need not search the published literature to find the answer to his or her query– the faculty member no longer need act in isolation. Instead, they can access the Portal and discover that indeed, we have an **EduApp** for that!

From the student perspective, **EduApps** will provide access to modular learning elements able to be downloaded as Web-based applications. An example from a recent class illustrates the potential utility of this approach. The course was an upper division course in the neural aspects of posture and locomotion. After a pre-test, the instructor decided to review certain aspects of neurophysiology – he did not, however, go all the way back to basic chemical thermodynamics assuming that students would be well acquainted with these concepts. Midterm results were poor and the instructor, frustrated by this performance, asked his students why they were unable to do better on the examination. One student offered the explanation that the instructor had asked students to apply chemical thermodynamics in what was essentially a class in biology. Students should not be expected to apply concepts learned in one venue to another, this student explained. The instructor was astonished but reflected that the students were becoming as isolated and siloed in terms of their learning as the faculty was in terms of their teaching. The **EduApps Portal** would address this deficiency in at least two ways. First, by having modular learning elements housed within the Portal, students could have reviewed membrane diffusion, resting potentials, and various aspects of chemical thermodynamics in a searchable database confident that the learning elements were valid and correct. Second, by adding specific links to examples in the thermodynamics learning elements, the **EduApps** could be used to encourage students to broaden their perspectives on the application of thermodynamics in other disciplines.

**3.3 Component Three: The Guided Personalized Student Learning (GPSLearning) System**

One of the main functions of the **IDSS** is to place information ***in context*** – to provide the right data in the right place at the right time. The ***Guided Personalized Student Learning*** or **GPSLearning** system is to play a similar role for students as the **IDSS** does for instructors.

Modern students use technology as a learning tool20 and are used to accessing Web-based resources. Indeed, most students live in a world of mobile and ubiquitous computing that higher education has yet to fully exploit29 . Moreover, evidence supports the idea that students learn more effectively when they take responsibility for their own learning20. Digital technology has the ability to enhance learning22 but has not lived up to its promise in part due to the poor design of educational technology 20,30. For the **EduApps** learning elements to be effective in enhancing student learning, we believe it is necessary to provide guided contextual information along with the elements themselves so that students can take full advantage of the access to what Peng and colleagues29 call ‘ubiquitous knowledge construction.’

**3.4 Component Four: SocraticNet – A Social Learning Network**

The envisioned **SocraticNet** social network is an interactive system using Web 2.0-based emerging technologies fostering communication and sharing among faculty, students and others (eg.,librarians) engaged in a particular course or other educational experience.

This learning environment is stimulated based on Socratic inquiry among teachers and learners. Students learn by sharing what they know, by asking questions, judging and evaluating the retrieved information, and using this information efficiently in completing their assignments or research papers. This approach results in multidimensional information flow – instructor to instructor, instructor to student, student to instructor, student to student – which adds a new richness to the interactions between faculty and students providing the framework for a true learning community.

The initial setup will be based upon the experiences reported by Conole and Culver6 with a social network with a similar goal of enhancing exchange between faculty concerning best teaching and learning practices. Their network – named Cloudworks – began with a set of initial conditions and then evolved as the result of system analysis and user feedback. Some of these initial conditions were to include social features, create restricted categories (in their case, pedagogy, tools and discipline), have a low barrier to entry, include user profiles, block personal/private content and generate certain classes of communications, such as resources, tools and people & communities.

We will utilize some of these ideas and approaches with certain modifications. For example, the entrance point to the network will be through the **IDSS** and **GPSLearning** dashboards, at least initially. Thus, some of the information, such as user (instructor and/or student) profiles could be located within those dashboards. In addition, the **EduApps Portal** will itself help to create classes of communication, such as when someone wants to access and download a specific learning or instructional element. Personal content will be excluded from this network6.

This system can be effectively used for peer review process. Students can review each other's projects, provide feedback and comments, and even suggest a few resources. Faculty members and others (eg, librarians) can also provide feedback and recommendations online. The entire team based projects can also be peer reviewed. Examples of good scholarly resources and citations can be illustrated virtually in an interactive fashion. Overall quality of research papers can be improved through this system of interactive collaboration, sharing and engaging in mutual learning and teaching.

While collaboration and working successfully in team setting is important, this system also monitors individual progress and independent thinking. Individual assignments integrated within the system require students to select unique scholarly research papers in responding to a question within the assignment.

Students’ success in finding the right information to answer the assignment questions is one assessment mechanism for the faculty members teaching the course. Other performance metrics can be incorporated as well. The new technology used in this network will also help faculty members save relevant data and provide a means to retrieve it whenever needed.

The system can be designed to provide automated guidance to students to help them select appropriate learning application depending on the subject they use. The module takes them to explore a particular concept or brings them to a section of appropriate databases pertaining to their research topic.

**4. System Implementation**

Integrating these four components together into a coherent system is a key factor if the approach is to succeed. It the system is too limited and constrained, it will lack impact and utility for the users and not be adopted. If the system is too broad and attempts too much, then it runs the risk of becoming diffuse and difficult to use. Again, this will lead to a lack of adoption by the key stakeholders – the students and faculty. The actual parameters of the design will have to be developed in collaboration with users but the initial plan will be to have a closed and asymmetric system.

Faculty will access the system in two ways. First, all aspects of the system will be accessible through the **IDSS**. The **IDSS** becomes available when an instructor is assigned to an specific educational experience, usually a course or course sequence. The **IDSS** provides course-related information (ISCP, CHRP, and ERNR), access to instructional elements through the **EduApps** and a entrance portal to the **SocraticNe**t social learning network. The instructor can also access the **EduApps Portal** and **SocraticNet** separately at any time, but each instance of an **IDSS** remains tied specifically to particular educational experience and does not persist when that specific experience terminates. For example, if there is an **IDSS** for Introductory Biomaterials, that **IDSS** remains operational only in the term in which the course is actually being taught. Thus, the **IDSS** is tied to an educational experience and not to any particular individual or individuals.

In contrast, the **GPSLearning** system is envisioned as being tied to a person – a specific student – and not to any particular educational experience. In this characteristic, the **GPSLearning** system is similar to some versions of ePortfolios where students gather materials over their entire academic career. However, rather than serving merely as a warehouse for data, the **GPSLearning** system is an interactive portal for communication (via **SocraticNet**), course information and learning elements via **EduApps**. The key aspect of this approach, which is shared by the faculty’s **IDSS**, is to provide the student with learning elements and other information ***in the context*** of their on-going educational experiences. Since that experience is curricular and develops over many years at an educational institution, the **GPSLearning** system must do the same.

The units of learning selection in this case are the instructional and learning elements housed in the **EduApps** database. Instructors access these elements – a process which will be monitored by the system3 – and recombine them in various ways to enhance their teaching efforts. The more elements are accessed, the stronger the apparent selection to maintain them. The same can be said of the learning elements accessed by students. Modifications of the instructional and learning elements are possible. Such modifications can be local - that is used by an instructor or student but not proposed for general use – or global. If a global modification is proposed by an instructor or student as a mutation of a current **EduApp** learning and/or instructional element, it will be sent into the **SocraticNet** for initial review by the learning community. If it passes initial review, it will receive provisional status as a new instructional or learning element. If the case of learning elements, a second review by discipline-specific experts is proposed to insure the element provides accurate and valid information before being retained as a new element in the **EduApps** database. In addition to use, student achievement will be applied as a selection pressure to determine the probability of recommending and retaining specific learning and instructional **EduApps**.

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