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Information Systems Education Journal

Encouraging Lifelong Learning through Tech Explorations

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Abstract

Information systems tools, techniques, and technologies are changing at an ever-increasing pace. Technical skills with operating systems, applications, and hardware are important to learn in an information systems curriculum so that students can be immediately productive upon graduating, but these skills may have a shelf life. Technical skills (like systems themselves) must be continually maintained, otherwise information systems professionals risk obsolescence. It is imperative that information systems educators provide students with the ability to learn effectively during school and after graduation. Many students struggle to learn independently, preferring instead to have clear learning paths provided for them. To encourage effective lifelong learning, a tech exploration assignment was implemented in an advanced networking security tools course at a midwestern university in the United States. In the assignment, students chose a network security topic according to their interests, developed a learning plan, carried out the learning plan independently, presented their findings, and submitted learning reflections. Results from student surveys showed that despite the challenges of stewarding their own learning process, they found the assignment to be a valuable learning experience that encourages lifelong learning. A detailed description of the assignment, student survey results, instructor observations, and implementation recommendations are provided.

Keywords: pedagogy, technology change, self-directed learning, lifelong learning

1. INTRODUCTION

It is a given that technology will continue to grow and evolve at a rapid pace. Though educators are aware that the specific technology platforms taught in classrooms today will likely be replaced in the future, educators must help students learn skills on these platforms that will be immediately useful upon graduating. Curriculum designers should be forward looking when selecting technologies to teach, but it is hard to predict which technologies society will adopt (Butler, 2016). Therefore, it is imperative that educators prepare students to continue learning after graduation so that students can adapt to change. Skill stagnation is a recipe for obsolescence.

Lifelong learning is important in any field, but especially in information systems because of the high rate of change. According to Caruth (2014, p. 1), "Adult students need to be taught how to learn in order to become lifelong, autonomous learners." Teaching how to learn should be a core part of an information systems degree. Curriculum that focuses too narrowly on specific technical skills may produce graduates that are unable to adapt to industry change (Randall & Zirkle, 2005).

Absent mandates from an employer, professionals have a plethora of options to keep their skills sharp. To keep pace with industry trends, professionals today might pursue skills in data analytics, application containerization, a new programming language, or any of a myriad of technologies that may not have been taught in their degree programs. Some may strive for industry certifications for career advancement or to change roles. In the current work, it is posited that students who are given opportunities to sculpt their learning paths during a degree program will gain confidence in their abilities to learn without explicit direction and will be in a better position to successfully pursue lifelong learning.

Lifelong learning is essential for ensuring that students have sufficient depth in a skill area. Students need both breadth and depth in their educations (Yates et al., 2018). Breadth gives students awareness of a wide range of technologies and skills that can be used to solve business problems. Depth refers to deeper domain-specific knowledge and stronger skills in a given topic. Over recent decades, depth in the field of information systems has increased, possibly due to increased specialization (Ozman, 2007). Instructors can encourage depth in the classroom by helping students learn and apply content independently (Katz, 2018). A learner-centered approach is critical to achieving depth (Manson & Pike, 2014).

In the next section, critical elements of the assessment process that relate to lifelong learning will be explained. Following the literature review is an explanation of a tech exploration assignment that aimed to develop self-learning skills that support lifelong learning.

2. LITERATURE REVIEW

In this paper, lifelong learning refers to continuing education that occurs after students leave academia. Lifelong learning is typically voluntary and self-motivated where the learner drives the learning process rather than an instructor (Department of Education and Science, Dublin (Ireland), 2000). Lifelong learning is frequently self-directed which takes grit--"consistency of interest and perseverance of effort" (Brooks & Seipel, 2018, p. 22). Because learners become their own instructors, they must be equipped with skills to carry out each step of the assessment process.

Assessment Process

The assessment process includes developing learning objectives, ensuring that curriculum is aligned with the objectives, creating a plan to assess objectives, gathering assessment data, then using the data to inform improvements (Allen, 2004). This process is carried out at several levels in academia including the degree level, course level, and individual lesson plan level. The assessment process has strong face validity. It makes sense to plan what students should learn, develop appropriate learning activities, check to see if they learned what they were supposed to, and make improvements based on data.

The assessment process is deceptively simple. There are several reasons why students struggle to implement this process independently. First, the process is not easy to carry out effectively. For example, it is all too easy to draft ambiguous learning objectives, develop curriculum that follows a textbook rather than defined learning objectives, and create subjective grading rubrics. The assessment process requires skills that must be practiced and honed. Second, it is likely that information systems students (like their peers in other business programs) have had little opportunity to implement the process independently. Students constantly participate in learning activities and receive assessment results, but rarely define learning objectives, develop learning activities, create assessment instruments, or reflect on their own learning process. If educators believe in the assessment process, it should be taught as a critical skill for lifelong learning.

Learning Objectives

Learning objectives are the expected outcomes of an academic activity, course, or program. They are often created by defining what knowledge and skills should be acquired by the completion of the learning phase. There are several reasons why information systems students might struggle to create clear learning objectives. First, when exploring a new technology, students may not know how much they might be able to learn in a given timeframe. Second, a topic might be so new that students struggle with precise terminology needed to create clear learning outcomes. Without specific learning objectives, it is hard to find focused resources to meet the objectives or define assessment criteria.

Curriculum Alignment

Learning objectives, methods, and assessments should be aligned for effective learning (Biggs, 2003). The number of curriculum options available to students has increased dramatically in recent years. Many people are putting tutorials online on sites like YouTube and Vimeo. Increasingly, people are going directly to video streaming sites to find information. YouTube is currently the world's second most popular search engine (Richards, 2018). Some people include video content online that complements books, such as the YouTube series "Automate the Boring Stuff with Python" (Sweigart, 2015). In addition, companies are increasingly putting free product training online, such as IBM's Academic Initiative (Gerber, 2015). Vendor-supplied training is a win-win for students and companies—the students have access to educational content and companies train prospective customers. Lastly, there has been an increase in Open Education Resources (OER) such as free textbooks and other training content. In summary, there is a wealth of information available to students online. Taking advantage of this information is a skill that must be developed.

Gathering Assessment Data

Assessments are embedded at different levels in academia. At the program level, ETS Major Field Tests are an example of assessing program-level learning objectives ("The ETS Major Field Tests," n.d.). Examinations are often given to measure course-level learning objectives. Quizzes, essays, and presentations are examples of unit-level assessments that typically receive quantitative grades and potentially qualitative feedback. Informal assessment occurs continuously as educators judge the quality of discussion, engagement, and demonstrated abilities despite no grades being recorded. For lifelong learning, students need to know how to measure whether they have mastered a skill without having a grading rubric provided to them. Evidence suggest that with training, learners can effectively assess their performance (Thawabieh, 2017).

Reflection

Analyzing assessment data is an important part of the learning process. Assessment identifies gaps in knowledge or skills. Students use assessment data to identify their areas of strengths and weaknesses. Educators should use assessment data to inform changes that might be needed in any part of the learning process. Assessment outcomes short of expectations could indicate ambiguous learning objectives, the need for improved curriculum, or problems with the assessment instrument. Continual improvement is only possible when reflection occurs at the end of the assessment process. Reflection allows learners to give themselves feedback which will enhance future learning activities (Thawabieh, 2017).

The remainder of this paper describes and evaluates a tech exploration assignment in which students plan and carry out their individual learning paths under the direction of an instructor. The details of the assignment are given in the next section.

3. TECH EXPLORATION ASSIGNMENT

A tech exploration assignment was introduced in an upper-division information systems course. The assignment had three core learning objectives. First, students would learn relevant topics related to the course objectives, such as network security tools. Second, students would be able to summarize and present findings effectively. Third, and most importantly, students would learn how to implement the assessment process. Students completed four tech exploration assignments during the course to allow them to improve their performance over time.

There were four principal components of the tech exploration assignment: the proposal, following the proposed learning plan, presentation of key findings, and a reflection. These elements were designed to map to the major activities in the assessment process. The individual elements of the tech exploration assignment will be described in detail in the following sections.

Proposal

In the first phase of the tech exploration, students submitted proposals that included their chosen topic, learning objectives, specific resources and activities that would be used to reach the learning objectives, estimates of how long different learning activities would take, and an explanation of how evidence of learning would be documented.

Topics needed to be related to network security, but a great deal of latitude was given to students to make the case that a given topic fell under the umbrella of network security. A list of potential topics was given to students to guide decision making. Example topics included the python programming language, web server configuration, the Ruby on Rails web framework, Metasploit, cloud computing, and information technology governance models. Students were encouraged to pick topics that would make hands-on learning possible.

Students needed to write specific, clear, and measurable learning objectives by defining what new skills and knowledge they would have by the end of the tech exploration. Bloom's taxonomy of educational objectives is a framework that helps educators choose appropriate goals and language when defining learning objectives (Krathwohl, 2002). The taxonomy employs cognitive process dimensions (such as remember, apply, and create) and knowledge dimensions (such as factual knowledge and procedural knowledge). The taxonomy was shared with the class to help identify learning outcomes and provide suggestions for verbs to use. Next, students described how these learning objectives would help them in their careers.

Students identified one or more resources they would use to reach the learning objectives. Points would be deducted if students said they would use "a python tutorial" instead of something more specific like "all of the basic tutorials on learnpython.org." Next, students estimated how much time they would spend carrying out the learning activities using the identified resources. An expectation of 8-10 hours was given as a target for the learning phase of the tech exploration. Lastly, students were asked to define how they would document evidence of learning. The evidence needed to be measurable through screenshots of code snippets they wrote, running websites they developed, online course quiz scores, custom installation guides, or other objective methods.

The grading rubrics for the proposal and other assignment elements are included in the appendix. The proposals were graded within a day of submission to validate the chosen topic and to ensure that the learning plan was well-defined. When a student selected a topic for which the instructor was not an expert, the student was told how much support the instructor would be able to give.

Following the Learning Plan

Once the proposal had been graded, students began following the learning plan. The instructor had less involvement in this phase of the assignment. Because the tech exploration was largely self-directed, the instructor monitored progress informally and helped students with problems as they arose. It was incumbent upon the students to work diligently and be proactive about asking for help in this stage of the assignment. Students were given reminders about upcoming due dates, but the instructor was not the one teaching the content. There was no grade given during this part of the project. This phase lasted 3-4 weeks. Because the bulk of the tech exploration work was done outside of class, in-class time was more devoted to instructor-designed curriculum and activities that supported program learning objectives.

Presentation of Findings

Students presented a summary of their topics to the class at the completion of the learning phase. They were told to present as if trying to convince their hypothetical employers how the topics they learned would be beneficial to their organizations. To prepare students for different presentation scenarios, students were required to use a different presentation method for each of the four tech explorations: a live demonstration, a whiteboard presentation, a slide-supported presentation, and a video. For the live demonstration, students were prohibited from using slides, but were allowed to use the classroom projector to show materials like applications or code. For the whiteboard presentation, students were prohibited from using any technology. The slide-supported presentation looked like a typical PowerPoint-backed presentation. Lastly, students created a video 5 to 8 minutes long that was played during the last day of class. Presentation grades were awarded on the evidence of planning and practicing.

Reflection

Students submitted learning reflections that included a copy of the learning objectives from the proposal, evidence of learning (such as sample code, course completion reports, or installation guides), an evaluation of the learning resources used, the time they spent on each learning activity, and a general reflection about their topic.

Effort during the learning phase of the tech exploration accounted for half of the assignment points. Students were expected to follow the learning plan and adapt to challenges in resourceful ways. Students who simply gave up when learning became difficult received low marks. The remainder of the reflection assignment grade was generally evaluated by assessing completeness and thoughtfulness.

The next section describes how the tech exploration assignment was evaluated by the students.

4. METHODOLOGY

Data was collected at a midwestern university in the United States. The tech exploration assignment was introduced in a capstone information systems course. All 9 students enrolled in the course (8 male, 1 female) completed 4 tech exploration assignments and completed the anonymous survey. No incentives were given for survey participation. The survey included quantitative assessments of various aspects of the assignment as well as qualitative questions that allowed students to provide open-ended feedback.

5. RESULTS

Quantitative and qualitative results from the student survey will be presented. After, instructor observations will be given.

Prompt	Mean	SD
I put more effort into my tech explorations than most college assignments.	2.67	1.87
I enjoyed the freedom to pick my own topic.	2.00	1.66
The instructor provided helpful guidance throughout the project.	1.22	0.44
Because of this assignment, I am more confident in my ability to learn new knowledge and skills after graduating.	1.78	1.30
This assignment will help me pursue lifelong learning.	2.11	1.54
I gained useful skills and knowledge from this assignment.	1.89	0.60
It was useful to learn to present in different formats.	1.33	0.71

Table 1: Overall Assignment Impressions (1=strongly agree, 7=strongly disagree)

Students rated the difficulty of the major elements of the tech exploration assignment. The questions used a 7-point Likert scale with values ranging from extremely easy (1) to extremely difficult (7). The means and standard deviations are in Table 2.

Element Difficulty	Mean	SD
Selecting a topic	5.33	1.66
Developing a learning proposal	3.44	1.33
Learning the topic using the resources identified in the proposal	3.67	1.58
Documenting the evidence of learning	3.22	1.79
Presenting a summary of your topic	2.89	1.69
Writing the reflection	2.22	1.48

Table 2: Difficulty of Assignment Elements (1=extremely easy, 7=extremely difficult)

Students rated the usefulness of the assignment elements using a 7-point Likert scale. The values ranged from extremely useful (1) to extremely useless (7). Table 3 provides the means and standard deviations of perceived usefulness.

Element Usefulness	Mean	SD
Selecting a topic	2.44	1.01
Developing a learning proposal	2.11	1.36
Learning the topic using the resources identified in the proposal	1.56	1.33
Documenting the evidence of learning	2.44	1.74
Presenting a summary of your topic	1.89	1.36
Writing the reflection	2.56	1.51

Table 3: Usefulness of Assignment Elements (1=extremely useful, 7=extremely useless)

Students were asked to provide a preference for the tech exploration assignment compared to other types of assignments. The preference was recorded using a 5-point Likert scale with values ranging from strongly preferring the alternative (-2) to strongly preferring the tech exploration (2). Means and standard deviations are in Table 4. The results indicate that students preferred the tech exploration over reading articles and watching videos. Students preferred group discussions and hands-on labs in class over the tech exploration. The data did not indicate a preference difference compared to class lecture.

Comparison Assignment	Mean	SD
Class lecture	0.00	1.32
Group discussions	-0.78	0.83
Hands-on labs in class	-1.56	0.53
Watching videos	1.11	1.05
Reading articles	1.11	1.17

Table 4: Preference of Assignments (Positive values indicate a preference toward tech explorations.)

Qualitative Feedback

Students were given the opportunity to provide open ended feedback but were not required to provide input. First, students were asked what parts of the assignment they enjoyed. Two students enjoyed presenting their topics to the class. One student enjoyed the struggle of the problem solving. Three students liked the ability to pick topics that specifically interested them. One student said, "I enjoyed learning at my own pace, but felt aimless at times."

Students were asked to explain the parts of the assignment that were most challenging. Several students mentioned that picking a topic was challenging. The next most common feedback was related to learning objectives. It was difficult to define learning objectives and stick to them.

Students were asked what changes should be made to the assignment to make it a better learning experience. Three of the five students who answered the question said they would not make any changes. One student recommended restricting topic selection to specific themes such as scripting, penetration testing, or cloud computing. One student wanted more flexibility in presentation methods.

Instructor Observations

It was fascinating to observe the topics selected by students. Several students chose topics related to the Raspberry Pi—a compact yet complete computing platform. Students used the Raspberry Pi devices for war walking (with guidance from the instructor on legality), advertisement blocking with the Pi-hole, and more. Some students reportedly spent about 20 hours on a single assignment getting their Raspberry Pi projects working. These projects incorporated operating systems, computer hardware, scripting, network configurations, and lots of troubleshooting which made them appropriate for a capstone information systems course.

Because students were invested in their own topics, they seemed to apply themselves more and dedicate as much time as needed to succeed. Overall, students seemed to work harder outside of class on tech exploration assignments than other types of assignments, such as reading chapters in a textbook.

Students generally appreciated being required to present using different methods. They did well when giving live demonstrations, explanations using a whiteboard, and when supported by slides. They struggled most when required to create a short video. Despite having access to professional software resources in campus media labs (such as Adobe Premiere), most students downloaded video creation software they found from search engines with varying degrees of success. Most students spent several hours learning to do basic video editing.

In the first tech exploration assignment, many students struggled to create specific and measurable learning objectives. In most cases, students were able to proceed with the learning plan despite learning objective ambiguity because the other parts of the learning plan were strong, but in rare instances students were asked to resubmit their proposals with improved learning objectives. Feedback for improvement was given, and the learning objectives improved in the subsequent tech exploration proposals.

Students often went beyond the resources they had identified in the proposals. Help forums and search engines were often used to clarify terms or troubleshoot problems. Students sought these additional resources without any prompting from the instructor and in most cases were able to address their knowledge gaps.

Failure on the assignments happened in a variety of ways. First, some students underestimated how much time it would take to reach the learning objectives. Generally, the first tech exploration of the semester opened students' eyes to the need for better planning. Second, some students tried to merely repeat content from previous classes and did not go into any greater depth. Failure of students to challenge themselves could sometimes be identified when reviewing the learning proposals. However, because much of the learning took place outside of the classroom, lack of effort was sometimes not apparent until the class presentation by which time it was too late for the instructor to make corrections. Lack of effort was evidenced in several ways. Sometimes, students reported their own lack of effort during the presentation to their peers. Other times, students did not fully document their evidence of learning or reported very few hours spent learning using the resources they had identified.

6. DISCUSSION

One concern when designing the tech exploration assignment was that because most learning would happen independently that students would feel unsupported. The results show that students felt supported through the assignment. The perception of support was likely driven by prompt feedback on assignment submissions, help selecting topics, and suggestions on scoping tech explorations appropriately for the time available.

The data support the idea that the tech exploration assignment supports lifelong learning. Students believed that the assignment helped them pursue lifelong learning and gave them skills to do so. While learning how to learn, students also reported learning useful skills and knowledge by completing the assignment.

According to students, the most difficult part of the assignment was picking a topic even though they enjoyed the freedom to pick their own topic. The other elements were rated as moderately difficult, except for writing the reflection which was rated the easiest of all assignment elements. The data suggests that the assignment is appropriately challenging. Learning the chosen topic was reported to be the most useful part of the assignment, but each element of the assignment was rated as useful.

Compared to other assignments, students preferred the tech exploration over reading articles and watching videos. However, they reported a preference for group discussions and hands-on labs in class. A preference for active, participatory learning is seen in the responses. Students may have expressed a preference for in-class labs and group discussions because in those assignments they do not have to select their own topics or create documentation—tech exploration elements that were rated most difficult. In the end, the tech exploration assignment should be seen as a complement and not a replacement for other types of assignments.

Overall, the results suggest that the tech exploration assignment is effective for encouraging lifelong learning, allowing students to dig deeper into topics of interest, developing presentation skills, and improving technical skills.

Suggestions for Implementation

Timely feedback is important for assignment submissions because students only have approximately three weeks after the learning proposal submission to complete all learning activities. If changes need to be made to the learning plans, students need to know quickly so that they can adjust their plans accordingly.

It is important to let students know the degree to which the instructor can help with the topic. For example, if the student wants to learn Django and the instructor has significant web development experience, it is likely that the instructor can give guidance and help troubleshoot if the student hits a roadblock. Students should be aware when the topic chosen is outside of the instructor’s area of expertise and will be less able to give helpful direction. Despite my own inexperience with the Raspberry Pi, I was able to help students find appropriate resources and solve problems. According to the survey results, students felt supported by the instructor despite lack of experience with every chosen topic.

Students must be held accountable for the quality of their work. While most students embraced these tech explorations to dig deep into a topic, some students tried to set learning objectives that did not push their learning far enough. Detailed grading rubrics can help set expectations for effort and provide an objective way to evaluate performance.

The tech exploration assignment was given in a capstone course of an undergraduate program. By this point in their academic careers, students had mastered information systems fundamentals and proven that they could use technology with less direction. It is less likely that this assignment would have been as successful in an introductory course. In some tech explorations, students created virtual machines, connected to servers using SSH, installed programming runtimes, and carried out similar tasks. These were tasks for which students had been prepared in previous courses.

If requiring students to create videos, tutorials should be developed that address common video requirements. Step-by-step instructions to create a video that combines clips from screen recording software and cell phone video would have helped students learn the majority of skills necessary for the tech exploration. Having mastered these basic techniques, students could spend more time producing content rather than learning video creation software.

Though the tech exploration assignment evaluated in the present work was given in a low enrollment course, the assignment could scale to larger classes. Only the presentation of findings would need adjustment to accommodate a large number of students. In high enrollment courses, presentation lengths could be shortened, students could present to peers in small groups, or students could be required to submit video presentations for each tech exploration.

Limitations

The sample size of this study was relatively low and there was no control group. True evaluation of the effectiveness of this assignment for supporting lifelong learning could only be done by evaluating student learning effectiveness after graduating. Periodic follow-up surveys would be necessary for ensuring that students continue to apply the formal learning process when pursuing new knowledge and skills after graduating.

7. CONCLUSIONS

Information technology changes rapidly and it is a challenge to keep skills current. In addition to assignments that include learning objectives for state-of-the-art technology, educators should ensure that students develop learning skills to facilitate lifelong learning. Despite having spent many years in school, students must be taught how to learn. Tech exploration assignments appear to be effective for teaching students how to learn.

Tech exploration assignments require students to choose a topic to study, develop a learning plan, follow the learning plan, document their evidence of learning, present findings, and reflect on the learning process. These assignments help students develop specific technical skills while helping them develop lifelong learning skills. It would be most appropriate to implement this type of assignment in upper division courses because students will have already developed strong technical foundations.

Instructors implementing these assignments should provide clear grading rubrics with expectations for performance. Prompt feedback should be given to ensure that students have time to make corrections to their learning path as early as possible. Instructors should be open with students about their areas of expertise and the extent to which they can provide support for the students' chosen topics. Overall, the tech exploration assignment complements other learning activities well.

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Editor's Note:

This paper was selected for inclusion in the journal as an EDSIGCON 2019 Meritorious Paper. The acceptance rate is typically 15% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2019.

Appendices and Annexures

The following grading rubrics were used to evaluate the tech exploration assignments.

Proposal Grading Rubric

	None	Below Expectation	Meets Expectation
Learning Objectives	0: None included	2: Vague and no application to career included	4: Clear and application to career included
Resources	0: None identified	2: Not specific (e.g. no URL, book name)	4: Specific resources identified
Time Estimation	0: No evaluation of resources or time included		2: Included
Evidence of Learning	0: Not included	3: Included, but unspecific	5: Clear, measurable evidence identified
		Total	15

Presentation Grading Rubric

	None	Below Expectation	Meets Expectation
Focus	0: No information shared	5: Information presented without a common thread	10: Clear presentation purpose
Polish	0: Unpracticed, sloppy	5: Some effort to prepare, but lacks polish	10: Evidence of rehearsal, free of mistakes, enthusiastic
		Total	20

Reflection Grading Rubric

	None	Below Expectation	Meets Expectation
Overall Effort	0: No attempt to follow the learning plan	10: Began following the learning plan but gave up when obstacles encountered	20: Followed the learning plan thoroughly or adapted to challenges in a resourceful way
Evidence of Learning	0: No evidence provided	5: Some evidence of learning provided, but not enough to validate the learning objectives	10: Evidence supports the completion of the learning objectives
Resource Evaluation and Time	0: No evaluation of resources or time included	2: Vague description of resources and time spent	5: Thoughtful assessment of resources and a breakdown of time spent
Summary	0: No summary included	2: Vague assessment included	5: Assessment shows thought about application in the field of information systems
		Total	40