Evaluation Plan for the Design of a Blended-Learning Organic Chemistry Unit

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Abstract

The evaluation plan for this blended-learning organic chemistry course will require the implementation of many different evaluation tools, and the patient cooperation of participants from diverse fields of expertise, user experience, and academic backgrounds. Using one-to-one formative evaluation practices as outlined by Dick, Carey, and Carey (2015), usability and accessibility of the course will be ascertained by surveys filled out by information technology (IT) experts, learning specialists (LS), and the intended end-users, learners. The IT expert will provide feedback concerning the usability of the site and its media resources, and the LS will issue opinions regarding the presence of motivational elements (as enumerated by Keller's ARCS Model [1987]). Learners will evaluate navigability, motivational elements, and content delivery. Revisions to the course in these key areas will be contingent upon the outcome and analysis of the evaluation tools.

Evaluation Plan for Design of a Blended-Learning Unit of Organic Chemistry

The function of this evaluation plan is to generate objective feedback concerning the efficacy of the blended-learning design in delivering content for an organic chemistry unit. The unit covers the three-dimensional geometry of molecules and how this geometry impacts intermolecular interactions and physical properties. My chief concern is whether learners find the blended-learning environment, (1) usable and accessible – with respect to the technology choices and implementation, (2) effective in content delivery by meeting the learning objectives supporting the above-mentioned content, and (3) motivational in design.

The evaluation plan is largely informed by formative evaluation practices outlined within the Dick, Carey, and Carey (2015) text, *The Systematic Design of Instruction*. Formative evaluation enables the collection of data and valuable feedback during the development process of instruction for the express purpose of improving its effectiveness *before* its distribution to a larger learner population (Dick et al., 2015, p. 283). Surveys and questionnaires (Appendix A) assessing the degree to which the course met the above objectives were derived from Keller's ARCS checklists (1987, 2010), Dick et al., (2015), and usability evaluation checklists proffered by Roy and Pattnaik (2014). The examination evaluating student success with the content was provided by the textbook publisher, Norton Publishing.

Background and Scope

About four years ago, an excellent chemistry student of mine asked if I could teach an organic chemistry course at our local, private, homeschool cooperative. As a potential nursing major, she had heard anecdotal accounts of college students in various nursing programs she was exploring, who simply could not pass the course - forcing many to change their programs of study. Having taken a year of organic chemistry in my own undergraduate program (molecular biology), I was no stranger to its difficulty – thus, I was immediately empathetic. After a

proposal for the class was accepted by the school's administrators, I had the pleasure of teaching organic chemistry for the first time.

Remarkably, this young woman's concerns were not without merit. One needs to take merely a cursory glance at the chemical education literature to realize that the perceived difficulty of organic chemistry among undergraduates is not merely anecdotal. Joel Karty, Assistant Professor of Chemistry at Elon University and author of an excellent organic chemistry text, *Organic Chemistry – Principles and Mechanisms,* laments, "Organic chemistry is a notorious class among undergraduates. Its perceived difficulty seems to resonate across all majors," (2007, p. 1209). Still other researchers have similarly recognized the fact that the course maintains an immutable reputation for difficulty. Grove, Hershberger, and Bretz (2008) remarked, "As students watch peers struggle, the myth that organic chemistry is an impossible, unforgiving subject is regrettably passed on to the next generation of students" (p. 157).

Recognizing the challenge that this course presents to many would-be doctors pharmacists, nurses, and engineers, I wondered why public and private high schools do not offer this as a fourth-year science elective – in the same way they offer anatomy and physiology, forensics, or environmental science. It appears the challenge to schools lies in the lack of instructional talent –there are not enough qualified teachers to take on such an advanced course. Knowing this, I had questioned the feasibility of delivering an organic chemistry course in a blended-learning environment, leveraging the benefits of both the face-to-face and online learning environs. In a theoretical blended-learning design, the more difficult concepts of organic chemistry could be relatively easy to disseminate in an online format, while the hands-on laboratory component could be managed face-to-face. The instructional talent necessary to facilitate such a lab could be easily satisfied by any qualified high school chemistry teacher. Bearing all of these factors in mind, I set to work on developing such a course. What remains to

be seen is if such a course is efficacious. Before investing a voluminous amount of time developing an entire course, however, I am interested in evaluating first a single unit or chapter.

Evaluation Methodology

In order to evaluate the effectiveness of the blended-learning organic chemistry course unit, it is important to employ methodologies and tools that are aligned to the project itself, and have their support in the literature. The methodology I plan to use will be that of formative evaluation by way of one-to-one evaluation with (1) IT experts, (2) learners, and, (3) learning specialists (Dick et al., 2015). Time does not permit the recruitment of a subject matter expert, nor even a small group study or field trials. Ideally, this methodology and the requisite tools will align with the criteria being evaluated.

Briefly stated, to evaluate the usability and navigability of the website and associated apps, I developed an instrument that assesses ease of use, efficiency, learnability, user satisfaction, and memorability, for the use of IT experts and the learners. The degree to which the blended-learning design could deliver course content will be measured the learner's objective performance on an exam developed by the textbook publisher. To determine whether the course satisfied motivational design strategies elucidated by Keller's ARCS Model (1987), I included many questions from Keller's checklists (p. 4, 5) in a survey, along with a questionnaire informed by Dick et al., (2015).

Usability and Accessibility

Usability, according to Roy and Pattnaik (2013, p. 535) defines: the ease of learning a new system (or software); the capability of holding the users interest; and, the ability to generate user satisfaction. The authors add that the *function* of assessing usability is to determine ways to improve the product, ascertain the user's general preferences, help users in goal achievement,

reduce errors contained within the system, and increase the likelihood the user will use the product again in the future.

Since my targeted learner will have to *navigate* through many different technologies and applications, a usability evaluation is critical. To deliver the course, I plan to use a Weebly website on which learners will access instructional videos (broken down into sections that align with the course textbook), homework assignments, quizzes, exams, and laboratory projects. The means by which I will assess usability will be by way of a one-on-one evaluation, using a Real-Time Walkthrough (Roy & Pattnaik, 2013, p. 540), conducted by two IT experts, and a temporally extended version of this by three of the course learners. The purpose of this one-to-one evaluation is ". . . to identify and remove the most obvious errors . . ." and, ". . . to obtain initial performance indications and reactions . . ." (Dick et al., 2015, p. 288).

The IT expert will be provided with a survey (Appendix A.1) and a link to the course. He or she will be allowed no more than ninety minutes navigation time, to assess the following:

- whether all links to videos and printables work
- the layout of the site: is it user friendly and aesthetic?
- the ability to achieve the goals of instruction from the learner's perspective
- the presence of any technological errors within the course (e.g., broken links, error messages).

In the event the IT expert ranks some items in the course as especially objectionable, he or she will write these down on a separate form, or discuss with me directly, in our one-on-one session.

The learners selected will similarly be provided with a survey (Appendix A.2) and link to the course, but they will not fill out the survey until the end of the course unit – which could take two to three weeks. The protocol for evaluation is by necessity different for the learner compared to the IT expert, because the learner's objectives for actually using the site will be different –

theoretically, they are accessing the site to learn the subject matter, and their interaction with the site will well exceed merely ninety minutes. The directives to the learners will also be different from that of the IT experts as they have never been asked to critique instruction. Dick et al., (2015, p. 291) remarks that learners may find it challenging to "criticize" an authority figure – thus, they will be assured that I am seeking their honest opinions and there will be no negative consequences for candid and open criticism.

Content Delivery

Since organic chemistry content is challenging in the best face-to-face environments, it is especially important that the online instruction is able to meet content standards established by the American Chemical Society (ACS) for the topics of address. Fortunately, Joel Karty, in his exemplary text, established learning objectives that meet ACS standards. These standards by nature are voluminous, demonstrating not only the problem of "tyranny of content" (Kennepohl, 2012, p. 671), but also demand the higher cognitive process dimension skills of application, analysis, evaluation, and synthesis (Mayer, 2002). The combined challenge of voluminous content and demand for higher order cognitive skills makes a blended-learning course all the more challenging since students, in effect, will have to teach themselves.

The question then, as to whether the course content is successfully delivered will be answered by way of an end-of-the-unit assessment (See Appendix A.3). I am hopeful that in observing universal design for learning ("UDL") practices, specifically the tenet of *multiple means of represent*ation (King-Sears, Johnson, Berkeley, Weiss, Peters-Burton, Evmenova, Menditto, Hursh, 2015), that students will successfully demonstrate content mastery. Students will not only have the written textbook/ solutions manual, homework assignments, and instructional videos, but face-to-face time for collaboration with their peers, as well. To minimize the effects of cognitive overload that many students encounter with texts that often

"say too much," the videos, each representing a single section from the text, can provide an alternative method of instruction. The evaluation methodology for content delivery will involve administering the exam provided by Norton Publishing to three students, allowing them only ninety minutes to complete.

Motivational Design

C.J. Blair, chemistry professor and columnist at the Oberlin Review wrote, "If Principles of Organic Chemistry were assigned a character based on its reputation, it would be the shark from Jaws swimming in a pool of undergraduate minnows," (2015, para. 1). If this statement were not bad enough, he adds, "I can't think of another class so notorious that its reputation extends beyond the people who take it" (para. 2). Blair laments that nearly every non-science major at Oberlin has an anecdote concerning a "friend" who stressed over a plummeting GPA on account of a failed exam, or botched lab. Organic chemistry's well-substantiated reputation oftentimes places students in the position of feeling intimidated before they even step foot in their class. Add to these dilemmas the problem of higher dropout rates evidenced in online learners (Allen & Seaman [2009] as cited by Stavredes & Herder [2012, p. 155]), it is obvious that a blended-learning organic chemistry course will demand *intentional* motivational design.

John Keller's ARCS Model for motivational instructional design consolidates many theories (*Self-Efficacy* [Bandura, 1977], *Origin and Pawn* [de Charms, 1968], *Attribution* [Weiner, 1974], *Self-Determination Theory* [Deci & Ryan], etc.) that facilitate learner motivation, and uses these to proffer actionable instructional strategies (Keller, 2010). When developing the unit in organic chemistry, I was careful to employ as many of these strategies as the technology and learning methods afforded. To determine whether these strategies were successfully implemented, I plan to have at least one or two learning specialists, in a one-on-one formative evaluation, systematically rate the degree to which these strategies were satisfied (See

Appendices A.4, A.5), using the Likert scale (Wakita, Ueshima, & Noguchi, 2012) in accordance with several of the recommendations provided by Dick et al., (2015, pp. 285-287), and Keller (1987, pp. 4, 5).

Evaluation Instruments

The actual instruments used in the evaluation plan come in the form of surveys and questionnaires informed by the motivation and information technology literature (as designated in their respective sections below); and a unit examination (to assess content knowledge) provided by Norton Publishing. In the development of all the surveys a Likert psychometric five-point scale was used, because of its reliability (Lissitz & Green [1975], and Boote [1981] as cited by Wakita, Ueshima, and Noguchi [2012, p. 534]). IT experts and learners will be asked to rank their experience with the website and learning materials, by checking one of five boxes that correlate to the scale as follows:

1 = needs significant improvement

2 = needs some improvement

3 = neutral

4 = satisfactorily met

5 = very satisfactorily met

Learning specialists, using this same scale will rank the degree to which the various objectives of the Keller's ARCS Model for learner motivation is satisfied.

The *neutral* anchor of *3* was inserted so as to allocate equal psychological distance between this category and those both sides of neutral; it seemed this was necessary so as to provide equal psychological distance between all categories (Wakita et al., (2012, p. 535). Wakita et al., (2012, p. 535) reported that when objectives or questions were negative, the distance between categories can become skewed – with the width of the neutral category being

more narrow than the others. For this reason, all questions were formulated using a *positive* narrative to minimize this skewing.

Dick et al., (2015, p. 291) recommends that the very assessment instruments used to evaluate the products themselves should be evaluated formatively before being used, so that the directions are clear to anyone using them. To ensure this, I had a proof-reader the same age as my high schoolers go through the instruments the learners will use (Appendix A.2, A.3), along with an adult who carefully read and made revisions on all of them, where necessary.

Usability and Accessibility

In the Real-Time Walkthrough, IT experts will be provided with a two-part evaluation (see Appendix A.1). Part I is a survey that is a modified version of the Norman's Cognitive Walkthrough, and Cognitive Walkthrough for the Web (Mahatody, Sagar, & Kolski, 2010, pp. 747, 748). The purpose of using this modified tool is to determine whether the "user" correctly interprets the prompts provided on the course website, and is able to follow the progression of the organic chemistry unit based upon those prompts (buttons, links, icons, etc.). Since the IT experts will be familiar with what constitutes excellent universal website design and user accessibility, their input will be quite valuable. For any survey objectives that receive a "1" or "2," the IT expert will provide on Part II of the evaluation suggestions for improvement. I added space for commentary from the IT experts because ". . . descriptive information rather than quantitative data probably yields the best information about clarity for revising the instruction," (Dick et al., 2015, p. 290).

A separate survey (Appendix A.2), with questions very similar to the one the IT experts complete, will be administered to three organic chemistry students after they complete the unit. The students may not have the experience of the IT expert when it comes to providing feedback with respect to layout or design, but as users it will be important to know whether they found the

website and its resources both usable and accessible. With the help of a high school proof-reader, I was cautious to craft these questions so they made the most sense.

Content Delivery

It cannot be overstated the importance of a well-designed website and technological accoutrements being aligned to specific learning objectives. In order to evaluate the efficacy of the instructional materials in content delivery, the three students have volunteered to take a standardized exam (Appendix A.3) developed by Norton Publishing that accompanies the course textbook. Following instruction, the students will take the proctored pencil-and-paper closed-book, closed-note exam, in a time period no greater than ninety minutes. A past organic chemistry student looked through each problem on this exam, to be sure they were clear.

Motivational Design

I hope to enlist the gracious services of two students in the IDT Program (hopefully Ann Harris for one on account of her science background), to act as learning specialists in the formative evaluation of this project. The learning specialist(s) will be provided with a survey (Appendix A.4) developed from Keller's ARCS Model (1987, pp. 4, 5), and a questionnaire (Appendix A.5) informed by Dick et al., (2015, pp. 285-287). Since in this particular evaluation I am interested in knowing whether the design is *motivational*, it made sense to write survey questions derived from Keller's original research (1987). Ideally, the answers as to whether the design demonstrated motivational components will be answered by the specialist(s) navigating the website, perusing through the homework questions, labs and quizzes, and having to watch only one or two of the videos.

As already mentioned, the questions in the learning specialist questionnaire (Appendix A.5) were derived from Dick et al., (2015, pp. 285-287) with some slight modifications. LS will

answer Y/ N questions on motivational strategies, with space to comment in more detail. While surveys certainly can

Participants

Participants completing the surveys, questionnaires and exams were not selected randomly. Instead, they were chosen for their expertise in media design (IT experts), instructional design (learning specialists), and their stakeholder interest to the organic chemistry course materials (students). The background and expertise of the participants correlated with the aspect of the evaluation under their review. Decisions concerning who to select as participants for particular sections of the evaluation plan were influenced largely by Table 11.1 provided by Dick et al., (2015, p. 286).

Usability and Accessibility

This aspect of the evaluation does not necessitate an evaluator with any background in organic chemistry, as the objective is to gain feedback with respect to the usability and accessibility of the website itself and its accompanying resources. For the Real-Time Walkthrough, however, I will solicit feedback from three organic chemistry students and two IT experts. The participants in both these groups have been strategically recruited, in accordance with recommendations by Dick et al., (2015), as specified below.

Roy and Pattnaik (2013, p. 540) assert that when it comes to evaluating the design of a website IT experts can provide, ". . . an immediate and concrete tactical analysis of the user's experience to make the product or website. . ." more user-friendly, and point out any flaws with respect to links and navigation. In addition to their IT background, Dick et al., (2015, pp. 287, 288) recommends that evaluators should be familiar with the target population, someone who can look at the courses resources ". . . through the target population's eyes and react." In the

recruitment of the two IT experts I was interested in both their background in IT, and their experience working with a target population very similar to mine.

I enlisted the services of Blas Morales because of his education and experience. He holds an MBA in Information Systems, and has been working in the IT industry for the last thirty years, of which the most recent fourteen have been in the university environment. Currently a business analyst and project manager at the University of Dayton, his role includes ensuring that product functionality and features are both identified and are fully met. This includes ensuring that end-user acceptance testing is completed and approved (with end-users often being students). Tiffani Puckett is my second choice as an IT expert. She currently teaches classes in computer applications, along with web and graphic design at a local, private high school. Since she also builds and maintains websites, and posts social media for several Cincinnati-area churches, she would have an excellent perspective as to what constitutes user-friendliness. I anticipate that the backgrounds of both Mr. Morales and Ms. Puckett will enable them to ". . . provide insights into the appropriateness of the material for the eventual performance context," (Dick et al., 2015, p. 288).

In addition to the actionable input I hope to receive from the IT experts, I am seeking feedback from the learners. The three learners selected for this particular evaluation have diverse experience with respect to using learning management software, with one in particular having a great amount of experience due to enrollment in online college classes. Another has never taken an online course before at all, and the third has minimal experience. Although none of these students have the experience of the IT experts – they can still provide excellent insight as to the website's (and accompanying materials) ease of use, and navigability. Whereas I will be looking to the IT experts for recommendations for improving course design and navigation, from the learners I hope to solicit feedback that is more visceral and affective, reflecting their general

attitudes towards course layout and navigability (did they grow frustrated, discouraged or hopeless?).

Content Delivery

The three organic chemistry students who will be selected represent various ability ranges within their group as recommended by Dick et al., (2015, p. 288). One learner in particular is extraordinary – has the necessary pre-skills for success, and highly intelligent. Another is a struggling student with a background known for *lacking* the pre-skills that would have been acquired in a solid, general chemistry course, while the third has abilities that are intermediate. Despite all the students having some degree of motivation (otherwise they would not be enrolled in the course), one in particular is very motivated to succeed because he wants to become a synthetic chemist. The other two do not have the same love for chemistry, but are instead taking the course to prepare them for college. Dick et al., (2015, p. 289) recommended using learners with not only variable abilities and pre-skills, but varying attitudes as well.

Since I am primarily concerned as to whether students can actually *learn* the content of the unit, these three learners, by virtue of their testing scores, will provide meaningful feedback as to the feasibility of this goal. The students selected will very well represent future targeted learners: specifically, high school students who have already taken general chemistry.

Motivational Design

This part of the evaluation demands the critical and trained eye of a learning specialist to ascertain whether or not the design is *motivational*; I hope to enlist one or two current IDT Program students. Current IDT candidates will more than likely have a familiarity with the learning theories for motivation (Self-efficacy, self-determination, locus of control, attribution, etc.) together with their requisite instructional design models. Because these candidates already took the Instructional Design course from Dr. Seo, they are aware of effective prescriptives for

learning design as outlined by Dick et al., (2015), Keller (1987), and many others. These particular participants will not be selected at random, since there is not a large, willing pool to recruit from, but will be selected on the basis of their expertise in science, current availability and interest, and my relationship with them.

Analysis Procedures

Many of the evaluation instruments used in the evaluation plan are subject to quantitative analyses. Because all of the surveys used a five-point Likert scale, they lend themselves to statistical analysis (calculating means for survey answers). The organic chemistry exam provided by Norton Publishing similarly enables statistical analysis. The questionnaires filled out by IT experts and learning specialists, however, necessitate more of a qualitative analysis.

Usability and Accessibility

The data collected from the IT experts and students will be examined and scored separately, even though both groups are answering similar questions. From the IT expert survey data, mean rankings for each objective will be calculated and recorded in a table (Appendix B.1), along with comments regarding suggestions for improvement. Mean rankings will also be recorded for the learner's survey (Appendix B.2). So as to not ". . . overgeneralize the data gathered from only one individual," objectives from both groups with *mean* rankings of 2 or less will undergo certain revisions, whereas those between 2 and 3 will only be considered for revision (Dick et al., 2015, p. 292). Mean rankings of objectives of four and above will be deemed as satisfactory.

The IT experts have been asked to provide suggestions for improvement on objectives they rank as 1 (needs significant improvement), and 2 (needs minimal improvement). Analysis will be conducted on these to determine the feasibility of the recommended revision.

Content Delivery

The test will serve as the evaluation tool for the efficacy of content delivery. Note that each question on the test key (Appendix A.3) shows the section within the text to which the question correlates. Success within a particular section in the textbook will to some extent be determined by the mean student performance within that section (Appendix B.3). As an example if students collectively miss 45% of the questions correlating to Section 2.2, but miss only 15% of the questions related to Section 2.6, I could surmise that Section 2.2 might need some revision, whereas Section 2.6 does not. For this project, sections that will be considered for revision will be those wherein 35% of the questions were answered incorrectly by the students (except Sections 2.3, and 2.8, due to the lack of questions in the test bank).

Again, since there will be only three exams to evaluate, care will be taken to not overgeneralize data collected from one student only. This is particularly important in this particular analysis, because the three students participating have varied backgrounds in pre-skills, and intellectual capacity (Dick et al., 2015, p. 292).

Motivational Design

From the surveys filled out by the learning specialist, I will similarly calculate mean rankings for each motivational strategy, and post in a table (Appendix B.4). Motivational strategies scoring at 2 or below will be considered seriously for revisions; those scoring between 2 and 3 will be merely considered, and those with mean rankings at 4 or above will be deemed satisfactory.

From the learning specialists, qualitative data will also be collected (Appendix A.5), and analyzed (Appendix B.5). The suggestions for improvement for motivational design will be carefully considered and evaluated as to feasibility.

Timeline and Conclusion

Table 1. Timeline of Project Completion

Task	Date
Evaluation Plan – first copy	September 8th
Evaluation Plan – revision	September 22nd
Complete the project undergoing analysis (completion of website, assignments, and instructional videos)	September 22nd
IT Expert Usability and Accessibility Analysis (Appendix A.1)	September 27th
Learner Usability and Accessibility Analysis (Appendix A.2, B.2)	September 27th
Progress Report	October 4th
Learning Specialist(s) Motivational Design Analysis (Appendices A.4, A.5)	October 18th
Content Delivery Analysis (from Learner Exams [Appendix A.3])	October 18th
Evaluation Report	October 25th
Artifact Revision	November 1st
Portfolio completion	November 15th
Presentation and defense	December 6th

The final revision of this evaluation plan will be completed by September 22nd, after suggestions made by other IDT students are carefully weighed. Once complete, the plan will provide the basis by which this blended-learning course will be evaluated for efficacy and feasibility. By September 22nd, I anticipate having all the instructional videos completed, and uploaded to the course website, ready for evaluation by the IT expert, the learning specialists, and actual use by the learners.

Evaluations from the IT expert and learners concerning the usability of the website and associated technology will be collected and analyzed by September 27th. Learning specialist(s) evaluations regarding the presence or absence of motivational strategies in the design will be analyzed by October 18th. Learner's exams will be collected, graded, and then evaluated for

success in content delivery by October 18th. These analyses, taken together, will determine the degree to which the project undergoes revisions and the nature of those revisions.

Once the final changes are made to the course, it will be linked to my portfolio. On December 6th, I plan to present and defend the instructional and technological choices I made in the development of this course. That defense will be buttressed by the literature.

Revision Notes

The most significant revisions made to the evaluation plan were to the evaluation instruments. Other revisions involved fleshing out in more detail evaluation methodology, choice of participants, and analysis. These changes came about after having read through Ann Harris's paper; since she just completed a dissertation last year, she provided an excellent example of what an evaluation plan should look like.

Evaluation Instruments

In the first draft of this Plan, I used a three-point survey, with the following scale:

0 = objective not met

1 = objective needs improvement

2 = objective satisfactorily met

After Ann Harris and Jose Avila suggested I consider the Likert scale, I found an excellent journal article (Wakita et al., 2012) on its use in psychometric testing and decided that a five-point scale would be far superior. I also changed the wording of the questions so they would all have a positive narrative, since Wakita et al., (2012, p. 535) reported that when content items were negative, the distance between categories of "strongly agree," "agree," "neither agree or disagree," "disagree," and "strongly disagree," can become skewed – with the width of the neutral category being more narrow than the others.

I added a Part II to both the IT experts and the learner's analysis of usability and navigability, which enables them to comment in more detail on those objectives in which they rated as "needs improvement," and "needs significant improvement." This was purposefully done because Dick et al., (2015, p. 290) stated that descriptive feedback yields the best information for revising the instruction, as opposed to the quantitative analysis only that survey's provide. Having the form close at hand, I am hoping these evaluators will take the liberty to express and jot down concerns, and suggestions for improvement.

The revisions in the evaluation tools demanded that I likewise change my analysis of the results. I had to change the ranges by which I would make judgements concerning the need for revisions, and allot more reporting space for the comments coming from the questionnaires. This was actually a good exercise, because in digging through the Dick et al., (2015) text, I found some additional excellent directives for analysis.

Clarity Concerning the Selection of Participants

Ann Harris pointed out the importance of describing in more detail the reasons behind my choices of participants. This prompted yet another look at the Dick et al., (2015) resource, and as a result, I changed my mind concerning some of them. I was originally going to randomly select three exams from the organic chemistry students to include in the analysis of content delivery, yet Dick et al., (2015) stated that for formative evaluations, random participant selection is not necessary; rather the evaluation data might provide greater insights if I purposely selected students with varying academic backgrounds, motivation levels, and attitudes.

Finally, Ruona Zhang wisely asked for clarification regarding the abilities of the learners selected for content delivery analysis. I clarified that these would be the same types of learners as those who would be future course users: students who have had only high school level general chemistry.

APPENDIX A

Evaluation Tools

Appendix A.1

IT Expert's Real-Time Walkthrough Survey – Part I

For each question, rate the degree to which the objective was met, from 1 to 5:
1 = needs significant improvement
2 = needs some improvement
3 = neutral
4 = satisfactorily met
5 = very satisfactorily met

For objectives scoring a 1 or 2, please provide a suggestion for improvement on Part II

1	2	3	4	5		Website/ Technology Assets Objectives:
□	□	□	□	□	1.	Website was accessible from the link provided.
□	□	□	□	□	2.	Website's homepage loaded quickly on the browser.
□	□	□	□	□	3.	Website interface was attractive.
□	□	□	□	□	4.	Homepage directs users to all course assets in a logical fashion.
□	□	□	□	□	5.	The amount of text on the homepage was appropriate.
□	□	□	□	□	6.	All graphical elements (images, icons) were properly presented.
□	□	□	□	□	7.	Font size big enough so that anyone with marginal vision could read the text on links, summaries, and check-off lists.
□	□	□	□	□	8.	The web design itself followed typical LMS protocol/ design.
□	□	□	□	□	9.	All links to lesson videos worked.
□	□	□	□	□	10.	All links to written materials worked.
□	□	□	□	□	11.	Contact information to the instructor was easily found.
□	□	□	□	□	12.	The link to the Discussion Board worked as evidenced by feedback by the website itself.
□	□	□	□	□	13.	The protocol for asking a general question using the Discussion Board was easy to understand.
□	□	□	□	□	14.	When the "instructor" replied on your theoretical question on the Discussion Board, I received notifications through my email.

Questionnaire modified from Norman's Cognitive Walkthrough, and Cognitive Walkthrough for the Web (Mahatody, Sagar, & Kolsi, 2010, pp. 747, 748)

IT Expert's Real-Time Walkthrough Survey Comments – Part II

In the spaces provided below, please provide suggestions for improvement for those objectives in Part I that were rated at a 1 or 2.

Objective No:	Your Rating	Recommendations for Improvement
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Appendix A.2

Learner's Real-Time Extended Walkthrough Survey

For each question, rate the degree to which the objective was met, from 1 to 5:
1 = needs significant improvement
2 = needs some improvement
3 = neutral
4 = satisfactorily met
5 = very satisfactorily met

For objectives scoring a 1 or 2, please provide a suggestion for improvement on Part II

1	2	3	4	5		Website/ Technology Assets Objectives:
□	□	□	□	□	1.	Were you able to access the website from the link provided?
□	□	□	□	□	2.	Did the website's homepage load quickly on your browser?
□	□	□	□	□	3.	Did you find the website interface simple and easy to use?
□	□	□	□	□	4.	Were the course assets, such as videos, homework, quizzes, laboratories and answer keys in places you'd expect to find them?
□	□	□	□	□	5.	Were you overwhelmed at the amount of text on the homepage? If too much, indicate with a "1" or "2," if just the right amount, "4" or "5."
□	□	□	□	□	6.	Did the images support the text? Did you find the images necessary?
□	□	□	□	□	7.	Font size just the right size in your browser? Too small, "1" or "2," just right "4" or "5."
□	□	□	□	□	8.	Were video, homework, lab and other links located in a logical place?
□	□	□	□	□	9.	Did all the links to lesson videos work?
□	□	□	□	□	10.	Did all the links to written materials work?
□	□	□	□	□	11.	Were you able to "contact me," easily?
□	□	□	□	□	12.	Did the link to the Discussion Board work?
□	□	□	□	□	13.	Was the protocol for asking a general question using the Discussion Board clear?
□	□	□	□	□	14.	When the "instructor" replied on your theoretical question on the Discussion Board, did you receive notifications through your email?

Questionnaire modified from Norman's Cognitive Walkthrough, and Cognitive Walkthrough for the Web (Mahatody, Sagar, & Kolsi, 2010, pp. 747, 748)

Learner's Extended Real-Time Walkthrough Survey – Part II

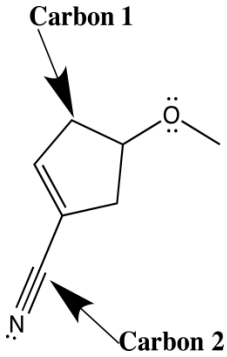
In the spaces provided below, please provide suggestions for improvement for those objectives in Part I that were rated at a 1 or 2.

Objective No:	Your Rating	Recommendations for Improvement
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Appendix A.3

Multiple Choice Organic Chemistry Exam (Karty, 2014)
For each question below, circle the single answer that best fits.

1. When applying VSEPR theory to determine the geometry about a central atom, it is important to count the number of electron groups. Separately consider the two atoms highlighted with an arrow in the molecule shown below. How many electron groups must be considered for each of these central atoms?



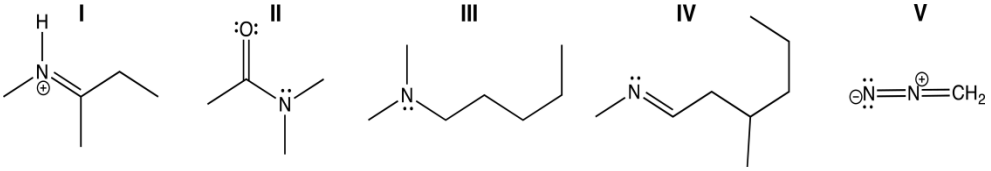
a. C_1 has two groups; C_2 has two groups.
b. C_1 has three groups; C_2 has four groups.
c. C_1 has four groups; C_2 has two groups.
d. C_1 has four groups; C_2 has three groups.
e. C_1 has four groups; C_2 has four groups.

ANS: C DIF: Medium REF: 2.1
OBJ: Apply VSEPR theory to understand organic structure and geometry.
MSC: Understanding

2. Which of the following statements is true about carbon tetrachloride, CCl_4?
   a. It is polar protic with tetrahedral geometry.
   b. The carbon has trigonal planar geometry.
   c. None of the C—Cl bonds has a dipole.
   d. It is miscible in water with 109.5° bond angles.
   e. It is polar aprotic with tetrahedral geometry at C.

ANS: E DIF: Easy REF: 2.1
OBJ: Relate polarity to molecular geometry and physical properties.
MSC: Evaluating

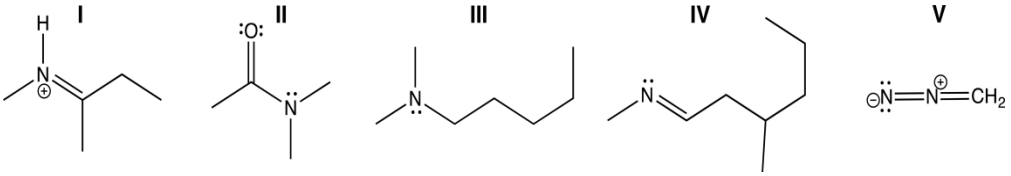
3. Which of the following molecules contains a nitrogen atom that has bent molecular geometry?



a. I
b. II
c. III
d. IV
e. V

ANS: D DIF: Medium REF: 2.1
OBJ: Apply VSEPR theory to understand organic structure and geometry.
MSC: Understanding

4. Which of the following molecules contain(s) a nitrogen atom that has trigonal pyramidal molecular geometry?



a. I only
b. II only
c. III only
d. I and II
e. II and III

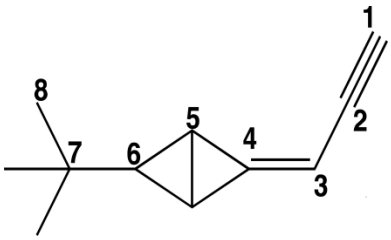
ANS: C DIF: Medium REF: 2.1
OBJ: Apply VSEPR theory to understand organic structure and geometry.
MSC: Understanding

5. Which cycloalkane contains a C—C—C bond angle that deviates from the ideal tetrahedral bond angle by approximately 20°?

a. A seven-membered cycloalkane
b. A six-membered cycloalkane
c. A five-membered cycloalkane
d. A four-membered cycloalkane
e. A three-membered cycloalkane

ANS: D DIF: Medium REF: 2.1 | 2.2
OBJ: Apply VSEPR theory to understand organic structure and geometry.
MSC: Understanding

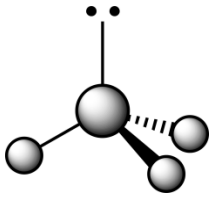
6. The carbon atoms in the molecule below are labeled 1–8. Which C—C—C bond angle in the molecule would be approximately 120°?



a. C_1-C_2-C_3
b. C_2-C_3-C_4
c. C_4-C_5-C_6
d. C_5-C_6-C_7
e. C_6-C_7-C_8

ANS: B DIF: Medium REF: 2.1 | 2.2
OBJ: Apply VSEPR theory to understand organic structure and geometry.
MSC: Understanding

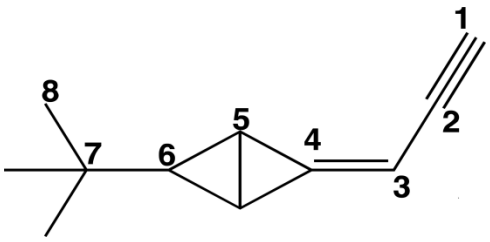
7. What are the approximate H—C—H bond angles expected for the carbanion whose structure is given in the ball-and-stick representation below?



a. 180°
b. 150°
c. 109.5°
d. 107°
e. 90°

ANS: D DIF: Medium REF: 2.1 | 2.2
OBJ: Apply VSEPR theory to understand organic structure and geometry.
MSC: Understanding

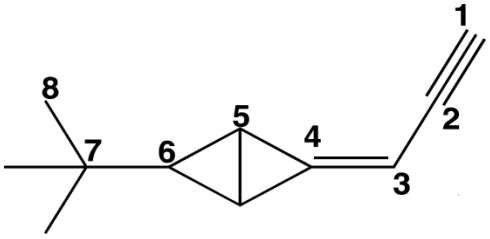
8. The carbon atoms in the molecule below are labeled 1–8. Which C— C— C bond angle in the molecule would be approximately 180°?



a. C_1-C_2-C_3
b. C_2-C_3-C_4
c. C_4-C_5-C_6
d. C_5-C_6-C_7
e. C_6-C_7-C_8

ANS: A DIF: Easy REF: 2.1 | 2.2
OBJ: Apply VSEPR theory to understand organic structure and geometry.
MSC: Applying

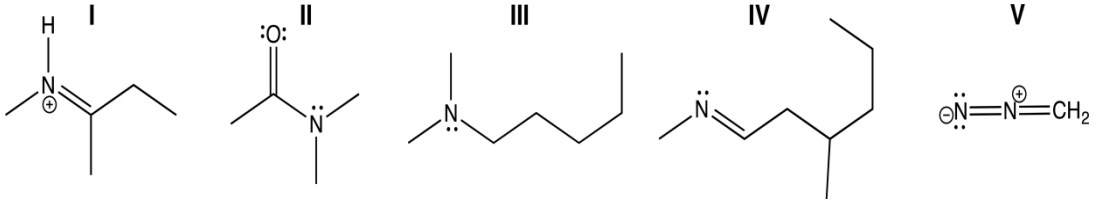
9. The carbon atoms in the molecule below are labeled 1–8. Which C— C— C bond angle in the molecule would be approximately 109.5°?



a. C_1-C_2-C_3
b. C_2-C_3-C_4
c. C_4-C_5-C_6
d. C_5-C_6-C_7
e. C_6-C_7-C_8

ANS: E DIF: Easy REF: 2.1 | 2.2
OBJ: Apply VSEPR theory to understand organic structure and geometry.
MSC: Applying

10. Which of the following molecules contains a nitrogen atom with linear geometry?



a. I
b. II
c. III
d. IV
e. V

ANS: E DIF: Medium REF: 2.1 | 2.2
OBJ: Apply VSEPR theory to understand organic structure and geometry.
MSC: Applying

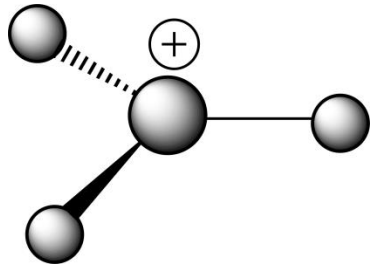
11. Which cycloalkane has the greatest ring strain per-CH_2-unit?
a. A seven-membered cycloalkane
b. A six-membered cycloalkane
c. A five-membered cycloalkane
d. A four-membered cycloalkane
e. A three-membered cycloalkane

ANS: D DIF: Medium REF: 2.1 | 2.2
OBJ: Understand the influence of ring strain on organic structure.
MSC: Analyzing

12. Which cycloalkane contains a C— C— C bond angle that deviates from the ideal tetrahedral bond angle by approximately 50°?
    a. A seven-membered cycloalkane
    b. A six-membered cycloalkane
    c. A five-membered cycloalkane
    d. A four-membered cycloalkane
    e. A three-membered cycloalkane

    ANS: E DIF: Medium REF: 2.1 | 2.2
    OBJ: Apply VSEPR theory to understand organic structure and geometry.
    MSC: Analyzing

13. Which of the following choices correctly describes the structure of the ball-and-stick representation with the formula H_3C^+?



    a. A carbocation with a tetrahedral carbon
    b. A carbocation with trigonal planar geometry
    c. A carbocation with unknown geometry
    d. A carbanion with a tetrahedral carbon
    e. A carbanion with trigonal planar geometry

    ANS: B DIF: Medium REF: 2.1 | 2.2
    OBJ: Apply VSEPR theory to understand organic structure and geometry.
    MSC: Analyzing

14. Which of the following cycloalkanes contains a C— C— C bond angle of approximately 90°?
    a. A seven-membered cycloalkane
    b. A six-membered cycloalkane
    c. A five-membered cycloalkane
    d. A four-membered cycloalkane
    e. A four-membered cycloalkane

    ANS: D DIF: Easy REF: 2.1 | 2.5
    OBJ: Apply VSEPR theory to understand organic structure and geometry.
    MSC: Understanding

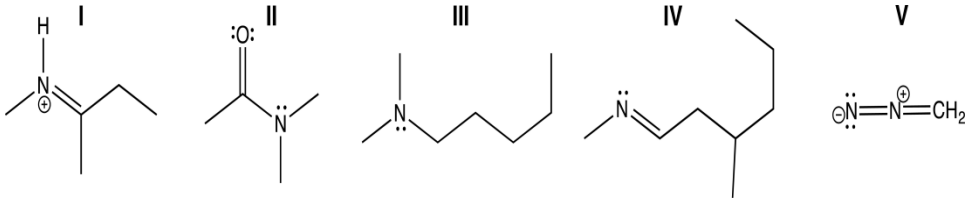
15. What is the VSEPR geometry for the carbon atom of a carbonyl?
    a. Linear
    b. Tetrahedral
    c. Trigonal pyramidal
    d. Trigonal planar
    e. Bent

    ANS: D DIF: Medium REF: 2.1 | 2.5
    OBJ: Apply VSEPR theory to understand organic structure and geometry.
    MSC: Understanding

16. What is the VSEPR geometry for any carbon atom in a phenyl ring?
    a. Linear
    b. Tetrahedral
    c. Trigonal pyramidal
    d. Trigonal planar
    e. Bent

    ANS: D DIF: Medium REF: 2.1 | 2.5
    OBJ: Apply VSEPR theory to understand organic structure and geometry.
    MSC: Understanding

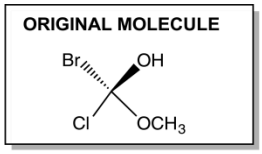
17. Which of the following molecules contains a trigonal planar nitrogen atom connected to two different tetrahedral carbon atoms?

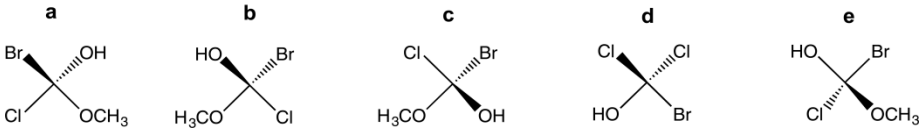


a. I
b. II
c. III
d. IV
e. V

ANS: B DIF: Medium REF: 2.1 | 2.5
OBJ: Apply VSEPR theory to understand organic structure and geometry. MSC: Understanding

18. Turn the original molecule shown below 90° in a clockwise direction on the plane of this paper. Which choice represents the product of this manipulation?

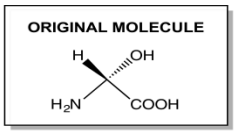


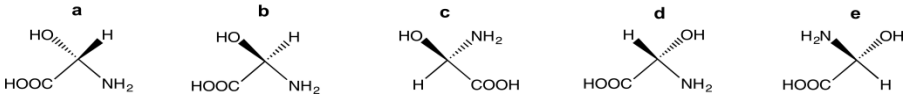


a. Structure a
b. Structure b
c. Structure c
d. Structure d
e. Structure e

ANS: C DIF: Medium REF: 2.2
OBJ: Execute a prescribed rotation and draw the molecule in its new orientation.
MSC: Applying

19. Rotate the molecule below 180°, in the same way you would flip a pancake or an egg during cooking. Which choice represents the product of the manipulation?





a. Structure a
b. Structure b
c. Structure c
d. Structure d
e. Structure e

ANS: B DIF: Medium REF: 2.2
OBJ: Execute a prescribed rotation and draw the molecule in its new orientation. MSC: Applying

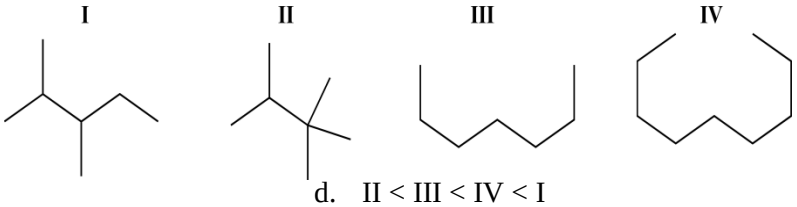
20. Which of the following molecules possesses at least one polar covalent bond but does not have an overall net molecular dipole?
    a. CH_4
    b. $CHCl_3$
    c. CH_2Cl_2
    d. CCl_4
    e. CH_3CH_3

    ANS: D DIF: Medium REF: 2.4
    OBJ: Differentiate between polar and nonpolar organic molecules.
    MSC: Remembering

21. Which of the following intermolecular forces is responsible for the boiling-point trends in alkanes?
    a. Hydrogen bond
    b. Ion–dipole
    c. Ion–ion
    d. Dipole–induced dipole
    e. Induced dipole–induced dipole

    ANS: E DIF: Easy REF: 2.4 | 2.6
    OBJ: Identify the relative strength of the common intermolecular forces as they apply to organic molecules. MSC: Analyzing

22. Rank the following molecules based on *increasing* boiling point.



    a. I < II < III < IV
    b. II < I < III < IV
    c. IV < III < I < II
    d. II < III < IV < I
    e. IV < III < II < I

    ANS: B DIF: Easy REF: 2.4 | 2.6
    OBJ: Identify the relative strength of the common intermolecular forces as they apply to organic molecules. MSC: Evaluating

23. Which functional group will engage in dipole–dipole interactions, but will *not* serve as a hydrogen-bond acceptor?
    a. Nitrile
    b. Ketone
    c. Alkyl bromide
    d. Carboxylic acid
    e. Amine

    ANS: C DIF: Medium REF: 2.5
    OBJ: Identify the intermolecular forces in which a functional group engages.
    MSC: Remembering

24. Which of the following functional groups contains *both* a hydrogen-bond donor and a hydrogen-bond acceptor?
    a. Alkyl fluoride
    b. Epoxide
    c. Carboxylic acid
    d. Nitrile
    e. Ketone

    ANS: C DIF: Easy REF: 2.5 | 2.6
    OBJ: Identify the intermolecular forces in which a functional group engages.
    MSC: Applying

25. Consider the structure of sodium benzoate, NaOC(O)Ph, the sodium salt of benzoic acid. In which of the following solvents would you predict sodium benzoate to be soluble?
I. Water, H_2O II. Pentane, $CH_3(CH_2)_3CH_3$ III. Diethyl ether, $(CH_3CH_2)_2O$
IV. Methanol, CH_3OH V. Acetone, $CH_3C(O)CH_3$

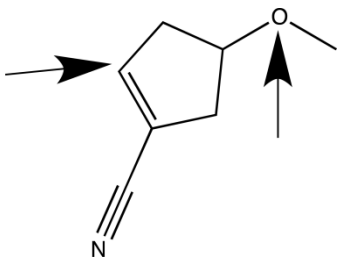
a. I only
b. I and III
c. I and IV
d. III and V
e. III and IV

ANS: C DIF: Medium REF: 2.5 | 2.7
OBJ: Utilize knowledge of chemical structure to identify solubility properties of an organic compound.
MSC: Evaluating

26. Identify the strongest intermolecular force.
a. Hydrogen bond
b. Ion–dipole
c. Ion–ion
d. Dipole–induced dipole
e. Induced dipole–induced dipole

ANS: C DIF: Easy REF: 2.6
OBJ: Identify the relative strength of the common intermolecular forces as they apply to organic molecules. MSC: Remembering

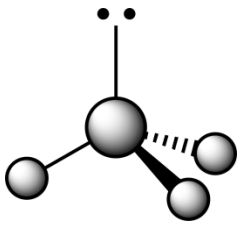
27. When applying VSEPR theory to determine the geometry about a central atom, it is important to count the total number of bonded and nonbonded electron groups. Separately consider the two atoms highlighted with an arrow in the molecule shown below. How many bonded electron groups must be considered for each of these central atoms?



a. C has two groups; O has two groups.
b. C has three groups; O has four groups.
c. C has three groups; O has two groups.
d. C has three groups; O has three groups.
e. C has four groups; O has four groups.

ANS: C DIF: Medium REF: 2.6
OBJ: Apply VSEPR theory to understand organic structure and geometry.
MSC: Understanding

28. How does the presence of the lone pair affect the geometry of the central atom in the following molecule?

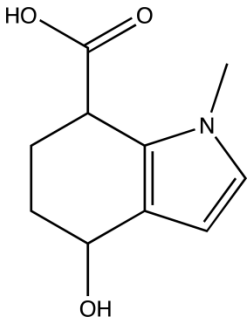


I. The lone pair is attracted to the nuclei of the three substituents, creating larger bond angles.
II. The lone pair repels the three sets of covalently bonded electrons.
III. The lone pair has no bearing whatsoever on the VSEPR geometry at the central atom.
IV. The bond angles are smaller than a traditional tetrahedral bond angle due to lone pair repulsion.

a. I
b. II
c. III
d. IV
e. II and IV

ANS: E DIF: Medium REF: 2.6
OBJ: Apply VSEPR theory to understand organic structure and geometry. MSC: Understanding

29. How many hydrogen-bond donors and acceptors are present in the following molecule?



a. One donor and four acceptors
b. Two donors and four acceptors
c. Two donors and three acceptors
d. One donor and three acceptors
e. Two donors and two acceptors

ANS: B DIF: Easy REF: 2.6
OBJ: Identify the intermolecular forces in which a functional group engages.
MSC: Applying

30. Identify the weakest intermolecular force.

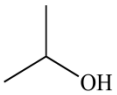
a. Hydrogen bond
b. Ion–dipole
c. Ion–ion
d. Dipole–induced dipole
e. Induced dipole–induced dipole

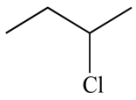
ANS: E DIF: Easy REF: 2.6
OBJ: Identify the relative strength of the common intermolecular forces as they apply to organic molecules. MSC: Analyzing

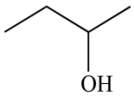
31. When mixed, which of the following pairs of compounds will exhibit *both* ion–dipole and ion–ion intermolecular attractive forces?

I $NaOCH_3$ 

II Na^0 

III F_2 

IV Br_2 

V NaCl 

a. I
b. II
c. III
d. IV
e. V

ANS: E DIF: Easy REF: 2.6
OBJ: Deduce the intermolecular forces that are possible between specified molecules.
MSC: Analyzing

32. What is the strongest intermolecular attractive force between an alcohol and a ketone?

a. Hydrogen bond
b. Ion–dipole
c. Ion–ion
d. Dipole–induced dipole
e. Induced dipole–induced dipole

ANS: A DIF: Medium REF: 2.6
OBJ: Identify the relative strength of the common intermolecular forces as they apply to organic molecules. MSC: Analyzing

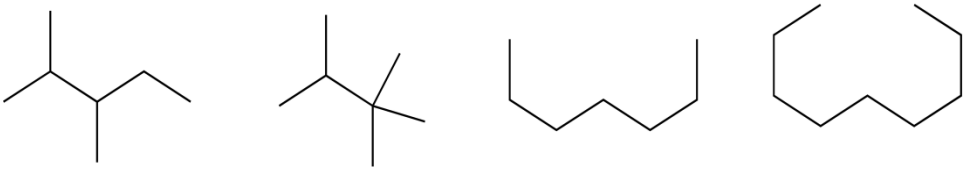
33. What is the strongest intermolecular attractive force possible between an alkyl chloride and an alkane?

a. Hydrogen bond
b. Ion–dipole
c. Ion–ion
d. Dipole–induced dipole
e. Induced dipole–induced dipole

ANS: D DIF: Medium REF: 2.6
OBJ: Identify the relative strength of the common intermolecular forces as they apply to organic molecules. MSC: Analyzing

34. Rank the following molecules based on *decreasing* boiling point.

I **II** **III** **IV**



a. I > II > III > IV
b. II > I > III > IV
c. I > III > IV > II
d. IV > III > I > II
e. IV > III > II > I

ANS: D DIF: Easy REF: 2.6, 2.8*
OBJ: Identify the relative strength of the common intermolecular forces as they apply to organic molecules. MSC: Evaluating

35. Select a phrase to complete this sentence: "_____ are induced dipole–induced dipole interactions common to nonpolar molecules such as hydrocarbons."
a. Electromotive forces
b. Hydrogen bonds
c. Ionic attractions
d. London dispersion forces
e. Mechanical forces

ANS: D DIF: Easy REF: 2.6 | 2.7
OBJ: Identify the relative strength of the common intermolecular forces as they apply to organic molecules. MSC: Remembering

36. Dimethyl sulfoxide (DMSO) is a polar aprotic solvent that is frequently used for organic reactions. Rank the following sodium halide salts for decreasing solubility in DMSO.
a. NaBr > NaCl > NaI
b. NaBr > NaI > NaCl
c. NaCl > NaI > NaBr
d. NaCl > NaBr > NaI
e. None of these salts is soluble in DMSO.

ANS: D DIF: Medium REF: 2.7, 2.9*
OBJ: Evaluate the solvation of an ion by a protic or aprotic solvent.
MSC: Analyzing

Appendix A.4

Learning Specialist's ARCS Model Strategies Survey Part I, page 1

For each statement, rate the degree to which the strategy was met by √ the box, from 1 to 5:
1 = needs significant improvement
2 = needs some improvement
3 = neutral
4 = satisfactorily met
5 = very satisfactorily met

1	2	3	4	5		***Attention-getting Strategies***
□	□	□	□	□	1.	Shows visual representations (images, photographs, models) of any important object or set of ideas or relationships (A2.1).
□	□	□	□	□	2.	Provides worked out examples of every instructionally important concept or principle (A2.2).
□	□	□	□	□	3.	Uses content-related anecdotes, case studies, biographies, etc. (A2.3).
□	□	□	□	□	4.	Varies the format of instruction (content presentation, practice problems, reflection, etc.) according to the attention span of the audience (A3.2).
□	□	□	□	□	5.	Varies the medium of instruction (platform delivery, film, video, print, etc.) (A3.3).
□	□	□	□	□	6.	Breaks up print materials by use of white space, visuals, tables, different typefaces, etc. (A3.4).
□	□	□	□	□	7.	Shifts between student-instructor interaction and student-student interaction (by way of labs, collaboration) (A3.6).
□	□	□	□	□	8.	Uses creativity techniques to have learners create unusual analogies and associations to the content (A5.1).
□	□	□	□	□	9.	Embeds problem-solving activities at regular intervals (A5.2).
1	2	3	4	5		***Relevance Strategies***
□	□	□	□	□	1.	States explicitly how the instruction builds on the learner's existing skills (R1.1).
□	□	□	□	□	2.	Uses analogies familiar to the learner from their past experience (R1.2).
□	□	□	□	□	3.	States explicitly the present intrinsic value of learning the content, as distinct from its value as a link to future goals (R2.1).
□	□	□	□	□	4.	States explicitly how the instruction relates to future activities of the learner (R3.1).
□	□	□	□	□	5.	To enhance achievement-striving behavior, provides opportunities to achieve standards of excellence under conditions of moderate risk (R4.1).
□	□	□	□	□	6.	To satisfy the need for affiliation, establishes trust and provides opportunities for no-risk, cooperative interaction (R4.3).
□	□	□	□	□	7.	Models enthusiasm for the subject taught (R5.3).

Survey derived from Keller, J.M. (1987). The systematic process of motivational design. *Performance & Instruction, 26*(9-10), 1-8. Letters next to the written strategy correlate to those in Keller's Tables 1 to 4.

Learning Specialist's ARCS Model Strategies Survey Part I, page 2

For each statement, rate the degree to which the strategy was met by √ the box, from 1 to 5:

1 = needs significant improvement
2 = needs some improvement
3 = neutral
4 = satisfactorily met
5 = very satisfactorily met

1	2	3	4	5		***Confidence Strategies***
□	□	□	□	□	1.	Incorporates clearly stated, appealing learning goals into instructional materials (C1.1).
□	□	□	□	□	2.	Provides self-evaluation tools which are based on clearly stated goals (C1.2).
□	□	□	□	□	3.	Explains the criteria for evaluation of performance (C1.3).
□	□	□	□	□	4.	Organizes materials on an increasing level of difficulty; that is, structure the learning material to provide a "conquerable" challenge (C2.1).
□	□	□	□	□	5.	Includes statements about the likelihood of success with given amounts of effort and ability (C3.1).
□	□	□	□	□	6.	Explains to students how to develop a plan of work that will result in goal accomplishment (C3.2).
□	□	□	□	□	7.	Attributes student success to effort rather than luck or ease of task when appropriate (i.e. when you know it's true!) (C4.1).
□	□	□	□	□	8.	Allows students opportunity to become increasingly independent in learning and practicing a skill (C5.1).
□	□	□	□	□	9.	Have students learned new skills under low risk conditions, but practice performance of well-learned tasks under realistic conditions (C5.2).
□	□	□	□	□	10.	Helps students understand that the pursuit of excellence does not mean anything short of perfection is failure; the student learns to feel good about genuine accomplishment (C5.3).
1	2	3	4	5		***Satisfaction Strategies***
□	□	□	□	□	1.	Verbally reinforces a student's intrinsic pride in accomplishing a difficult task (S1.2).
□	□	□	□	□	2.	Allows a student who masters a task to help others who have not yet done so (S1.3).
□	□	□	□	□	3.	Gives verbal praise for successful progress or accomplishment (S3.1).
□	□	□	□	□	4.	Avoids the use of threats as a means of obtaining task performance (S4.1).
□	□	□	□	□	5.	Avoids surveillance (as opposed to positive attention) (S4.2).
□	□	□	□	□	6.	Avoids external performance evaluations whenever it is possible to help the student evaluate his or her own work (S4.3).

Survey derived from Keller, J.M. (1987). The systematic process of motivational design. *Performance & Instruction, 26*(9-10), 1-8. Letters next to the strategy correlate to Keller's Tables 1 to 4.

Appendix A.5

Learning Specialist's Questionnaire – Motivational Design – Part II

Question	Response
1. Do the materials reflect a natural progression in skills, so as to minimize frustration on the part of the learner? Comments:_____ _____	Y/ N
2. What do you perceive to be the chief motivational value of the materials? Comments:_____ _____	N/A
3. Do you think learners will find the materials *relevant* to their needs and interests in both the short term and long term? Comments:_____ _____	Y/ N
4. Do you think there are adequate cues to *gather* the learner's *attention*? Comments:_____ _____	Y/ N
5. Are there adequate steps taken to *maintain* the learner's *attention*? Comments:_____ _____	Y/ N
6. Could more be done to facilitate learner *confidence*? If so, describe. Comments:_____ _____	Y/ N
7. Besides satisfying a requirement for granting a degree, are there other elements within the course that might generate learner *satisfaction*? If so, please describe those. Comments:_____ _____	Y/ N
8. When looking through the course materials and the website, did you get the impression that course success can be realized with hard work? Comments:_____ _____	Y/ N
Questions are modified from Dick, Carey, and Carey, 2015, pp. 286, 287.	

APPENDIX B

Data and Analysis

Appendix B.1

IT Expert's Real-Time Walkthrough Survey Data and Analysis

Each question was rated from 1 to 5, accordingly:

1 = needs significant improvement
2 = needs some improvement
3 = neutral
4 = satisfactorily met
5 = very satisfactorily met

For objectives scoring a 1 or 2, IT experts provided suggestions for improvement.

Mean Ranking		Website/ Technology Assets Objectives:	Suggestions for Improvement
_____	1.	Website was accessible from the link provided.	
_____	2.	Website's homepage loaded quickly on the browser.	
_____	3.	Website interface was attractive.	
_____	4.	Homepage direct users to all course assets in a logical fashion.	
_____	5.	The amount of text on the homepage was appropriate.	
_____	6.	All graphical elements (images, icons) were necessary.	
_____	7.	Font size big enough so that anyone with marginal vision could read the text on links, summaries, and check-off lists?	
_____	8.	The web design itself followed typical LMS protocol/ design.	
_____	9.	All links to lesson videos worked.	
_____	10.	All links to written materials worked.	
_____	11.	The contact information to the instructor was easily found.	
_____	12.	The link to the Discussion Board worked, as evidenced by feedback from the website.	
_____	13.	The protocol for asking a general question using the Discussion Board was easy to understand.	
_____	14.	When the "instructor" replied on your theoretical question on the Discussion Board, you received notifications through your email.	

Questionnaire modified from Norman's Cognitive Walkthrough, and Cognitive Walkthrough for the Web (Mahatody, Sagar, & Kolsi, 2010, pp. 747, 748)

Items scoring 0 will require revisions; 1 will be considered; 2 will be deemed satisfactory.

Appendix B.2

Learner's Extended Real-Time Walkthrough Survey Data and Analysis

Each question was rated from 1 to 5, accordingly:

1 = needs significant improvement
2 = needs some improvement
3 = neutral
4 = satisfactorily met
5 = very satisfactorily met

For objectives scoring a 1 or 2, IT experts provided suggestions for improvement.

Mean Ranking		Website/ Technology Assets Objectives:	Suggestions for Improvement
____	1.	Were you able to access the website from the link provided?	
____	2.	Did the website's homepage load quickly on your browser?	
____	3.	Did you find the website interface simple and easy to use?	
____	4.	Were the course assets, such as videos, homework, quizzes, laboratories and answer keys in places you'd expect to find them?	
____	5.	Were you overwhelmed at the amount of text on the homepage? If too much, indicate with a "1" or "2," if just the right amount, "4" or "5."	
____	6.	Did the images support the text? Did you find the images necessary?	
____	7.	Font size just the right size in your browser? Too small, "1" or "2," just right "4" or "5."	
____	8.	Were video, homework, lab and other links located in a logical place?	
____	9.	Did all the links to lesson videos work?	
____	10.	Did all links to written materials work?	
____	11.	Were you able to "contact me," easily?	
____	12.	Could you tell whether the link to the Discussion Board worked?	
____	13.	Was the protocol for asking a general question using the Discussion Board clear?	
____	14.	When the "instructor" replied on your theoretical question on the Discussion Board, did you receive notifications through your email?	

Questionnaire modified from Norman's Cognitive Walkthrough, and Cognitive Walkthrough for the Web (Mahatody, Sagar, & Kolsi, 2010, pp. 747, 748)

Items scoring 0 will require revisions; 1 will be considered; 2 will be deemed satisfactory.

Appendix B.3

Content Delivery Analysis from Student Scores on Norton-published Exam

Section	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8
Questions on Exam	*1 to 18*	*5 to 13, 18, 19*	*N/A*	*20 – 22*	*15 – 17, 23 - 25*	*21, 22, 24, 26 - 35*	*25, 35, 36*	*N/A*
Mean Scores			N/A					N/A

Appendix B.4

Data Analysis of Learning Specialist's ARCS Model Strategies Survey Part I, page 1

For each statement, the motivational strategy was rated accordingly:
1 = needs significant improvement
2 = needs some improvement
3 = neutral
4 = satisfactorily met
5 = very satisfactorily met

Mean Ranking		
		Attention-getting Strategies
_____	1.	Shows visual representations (images, photographs, models) of any important object or set of ideas or relationships (A2.1).
_____	2.	Provides worked out examples of every instructionally important concept or principle (A2.2).
_____	3.	Uses content-related anecdotes, case studies, biographies, etc. (A2.3).
_____	4.	Varies the format of instruction (content presentation, practice problems, reflection, etc.) according to the attention span of the audience (A3.2).
_____	5.	Varies the medium of instruction (platform delivery, film, video, print, etc.) (A3.3).
_____	6.	Breaks up print materials by use of white space, visuals, tables, different typefaces, etc. (A3.4).
_____	7.	Shifts between student-instructor interaction and student-student interaction (by way of labs, collaboration) (A3.6).
_____	8.	Uses creativity techniques to have learners create unusual analogies and associations to the content (A5.1).
_____	9.	Embeds problem-solving activities at regular intervals (A5.2).
		Relevance Strategies
_____	1.	States explicitly how the instruction builds on the learner's existing skills (R1.1).
_____	2.	Uses analogies familiar to the learner from their past experience (R1.2).
_____	3.	States explicitly the present intrinsic value of learning the content, as distinct from its value as a link to future goals (R2.1).
_____	4.	States explicitly how the instruction relates to future activities of the learner (R3.1).
_____	5.	To enhance achievement-striving behavior, provides opportunities to achieve standards of excellence under conditions of moderate risk (R4.1).
_____	6.	To satisfy the need for affiliation, establishes trust and provides opportunities for no-risk, cooperative interaction (R4.3).
_____	7.	Models enthusiasm for the subject taught (R5.3).

Survey derived from Keller, J.M. (1987). The systematic process of motivational design. *Performance & Instruction, 26*(9-10), 1-8. Letters next to the written strategy correlate to those in Keller's Tables 1 to 4.

Data Analysis of Learning Specialist's ARCS Model Strategies Survey Part I, page 2

For each statement, the motivational strategy was rated accordingly:

1 = needs significant improvement
2 = needs some improvement
3 = neutral
4 = satisfactorily met
5 = very satisfactorily met

Mean Ranking		***Confidence Strategies***
_____	1.	Incorporates clearly stated, appealing learning goals into instructional materials (C1.1).
_____	2.	Provides self-evaluation tools which are based on clearly stated goals (C1.2).
_____	3.	Explains the criteria for evaluation of performance (C1.3).
_____	4.	Organizes materials on an increasing level of difficulty; that is, structure the learning material to provide a "conquerable" challenge (C2.1).
_____	5.	Includes statements about the likelihood of success with given amounts of effort and ability (C3.1).
_____	6.	Explains to students how to develop a plan of work that will result in goal accomplishment (C3.2).
_____	7.	Attributes student success to effort rather than luck or ease of task when appropriate (i.e. when you know it's true!) (C4.1).
_____	8.	Allows students opportunity to become increasingly independent in learning and practicing a skill (C5.1).
_____	9.	Have students learned new skills under low risk conditions, but practice performance of well-learned tasks under realistic conditions (C5.2).
_____	10.	Helps students understand that the pursuit of excellence does not mean anything short of perfection is failure; the student learns to feel good about genuine accomplishment (C5.3).
		Satisfaction Strategies
_____	1.	Verbally reinforces a student's intrinsic pride in accomplishing a difficult task (S1.2).
_____	2.	Allows a student who masters a task to help others who have not yet done so (S1.3).
_____	3.	Gives verbal praise for successful progress or accomplishment (S3.1).
_____	4.	Avoids the use of threats as a means of obtaining task performance (S4.1).
_____	5.	Avoids surveillance (as opposed to positive attention) (S4.2).
_____	6.	Avoids external performance evaluations whenever it is possible to help the student evaluate his or her own work (S4.3).

Survey derived from Keller, J.M. (1987). The systematic process of motivational design. *Performance & Instruction, 26*(9-10), 1-8. Letters next to the strategy correlate to Keller's Tables 1 to 4.

Appendix B.5

Qualitative Data - Learning Specialist's Questionnaire on Motivational Design – Part II

	Question	Response
1.	Do the materials reflect a natural progression in skills, so as to minimize frustration on the part of the learner? Comments:_____ _____	Y/ N
2.	What do you perceive to be the chief motivational value of the materials? Comments:_____ _____	N/A
3.	Do you think learners will find the materials relevant to their needs and interests in both the short term and long term? Comments:_____ _____	Y/ N
4.	Do you think there are adequate cues to *gather* the learner's attention? Comments:_____ _____	Y/ N
5.	Are there adequate steps taken to *maintain* the learner's attention? Comments:_____ _____	Y/ N
6.	Could more be done to facilitate learner confidence? If so, describe. Comments:_____ _____	Y/ N
7.	Besides satisfying a requirement for granting a degree, are there other elements within the course that might generate learner satisfaction? If so, please describe those. Comments:_____ _____	Y/ N
8.	When looking through the course materials and the website, did you get the impression that course success can be realized with hard work? Comments:_____ _____	Y/ N

Questions are modified from Dick, Carey, and Carey, 2015, pp. 286, 287.

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