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A Systematic Planning for Science Laboratory Instruction: Research-Based Evidence

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The aim of this study is to develop an instructional design model for science laboratory instruction. Well-known ID models were analysed and Dick and Carey model was imitated to produce a science laboratory instructional design (SLID) model. In order to validate the usability of the designed model, the views of 34 high school teachers related to SLID's steps were gathered via a survey. The survey results on the basis of necessity of SLID's elements showed that the mean of the items was extremely high. Statistical analysis on teachers' views about SLID across teachers' gender, subject and school type resulted in no differences. The outcome of this study, that is SLID, is expected to enhance the process of teaching and learning science in laboratory setting.

Keywords: instructional design, science laboratory, Dick and Carey ID model

INTRODUCTION

Laboratory instruction

Science educational researchers over the past several decades have suggested that laboratory courses are beneficial, offer students a potentially rich learning experience and make unique contributions to science education (Byers, 2002; Lee, Lai, Yu & Lin, 2012). Similarly, today in teaching science a great importance is given to laboratory practice (Aydoğdu & Yardımcı, 2013). Arzi (1998) states the importance of laboratory instruction as: "the laboratory is believed to be a sine qua non of both science and school science" (p.596). There are various intentions, such as understanding scientific concepts, increasing interest and motivation, developing scientific practical skills, carrying out scientific inquiry, and understanding the nature of science, in conducting laboratory sections (Hofstein & Lunetta 1982, 2004; Freedman 1997; Henderson et al. 2000; Byers, 2002). Moreover, Aydoğdu and Yardımcı (2013) define the purpose of laboratory training as to arouse students' interest, creative thinking and curiosity to develop their problem-solving skills, to provide conceptual understanding and practical skills. Furthermore, Erökten (2010) states the basic philosophy of laboratory instruction as the extraction of results

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through the observation of the events and cases in the laboratory environment.

Although current study does not aim to investigate the usefulness of laboratory-based instruction, it should be noted that laboratory courses could have a positive impact on students' achievement in science (Secker & Lissitz, 1999). Many educational researchers suggest that laboratory courses are beneficial, integrate theory and practice, and many positive learning outcomes can potentially be attributed to students' laboratory experiences (Pickering, 1980; Tobin, 1990; Hofstein & Lunetta, 2003; Pradesa & Espinar, 2010; Lee, Lai, Yu & Lin, 2012).

Although there is an agreement about positive impact of laboratory instruction, there is a decline in the number of science laboratory courses being offered in some other parts of the world (Smith 2004; Lock 2010). Similarly, even though laboratory studies are the indispensable of science education, in Turkey, in terms of understanding as well as the physical infrastructure, the necessary importance has not been yet given to it (Erökten, 2010).

There are many problems related to the decline in the number of science laboratory courses in the world. One of the problems may be attributed to the lack of effectively and efficiently designed instructions in the laboratory environment. In other words, a systematic planning of laboratory course can attract teachers' attention and motivate them to offer laboratory activities to their students. ''Although laboratory courses are time-consuming and may require additional teaching resources, educators should reconsider their advantages'' (Lee, Lai, Yu & Lin, 2012, p.179). Consequently, one way in designing an effective laboratory course may be to plan the course with the aid of instructional design models.

State of the literature

- The laboratory is believed to be a sine qua non of science. The purpose of laboratory training is to arouse students' interest, creative thinking and curiosity to provide conceptual understanding and practical skills.
- There is a decline in the number of science laboratory courses being offered in some other parts of the world. One of the problems may be attributed to the lack of effectively and efficiently designed instructions in the laboratory environment.
- Instructional Design is the systematic usage of principles in planning learning resources.

Contribution of this paper to the literature

- This study is remarkable in terms of carrying the principals of the instructional design models in planning the science laboratory instruction. It indicates that the Dick and Carey ID model was imitated successfully in the design and development of SLID.
- The present study developed a laboratory course design emerging from instructional design models and this design is validated through experts and science teachers' feedback.
- The applied survey confirmed that the combination of SLID elements, such as setting the goal, safety precautions, laboratory execution and laboratory report, together with a follow-up rapid feedback system, are core aspects of a powerful environment for laboratory courses.

Instructional design

What does it mean "to design instruction"? Designing instruction is the same as designing a car, a building, or a computer system. "Design" refers to the actions, the processes, or procedures that are intended to accomplish a particular outcome or goal. The design process begins by clearly specifying the goals to be achieved. Then all subsequent actions and decisions focus on the goals. Eventually the resulting product or outcome is evaluated by assessing how well it achieves the intended goals (Zook, 2001). Castro, Sicilia and Prieto (2012) summarize the function of instructional design theories as follows:

> Instructional design theories are design theories that offer explicit guidance on how to help people to learn in specific situation. They can be used to guide the design of learning activities and the arrangement of associated resources. These theories are currently expressed in natural

language, but they are often given some structure in terms of methods and conditions. (p. 180)

Some more perspectives are as follows: Instructional Design (ID) is the systematic usage of principles in planning learning resources. In other saying, it allows instructional systems to be created from a system perspective (Merril, 1996). It helps teachers to organise the body of knowledge for use in the learning process (Gagne, Briggs & Wager, 1992). It guides teachers in the construction of learner resources by considering elements of the instructional context and the learner's learning goals. One way to make instruction more effective and relevant is to follow an ID procedure in a systematic way (Reiser, & Dempsey, 2007). Application of the ID requires a disciplined approach to indicating, for example, the sequence of activities and the results of each stage (Castro, Sicilia & Prieto, 2012).

ID models cover stages ranging from analysis to implementation and evaluation. While some models propose a linear sequence for these activities, some others recommend models that consider iterations and incremental developments. Moreover while some models internalize step-by-step approach some others use an integrated design in terms of process-product relationships. It should be emphasized that these models focus on phases of the instruction and do not provide guidance to the teachers when performing the activities.

Several ID models are used widely and are taught as courses in education faculties. Among them, as a simplified model for learning resource construction, ADDIE (Analysis, Design, Development, Implementation and Evaluation) is the most widely used model (Peterson, 2003). A more comprehensive analysis of the instructional design is beyond the scope of the current study; however, some other famous models such as ASSURE (Heinich, Molenda, & Russell, 1993), ARCS (Keller, 1987), Dick and Carry Model (Dick, Carry, & Carry, 2001), Kemp (2004) Model, Posner (2001) Model, Tyler (1971) Model, Smith and Ragan (1999) model, and Gerlach and Ely Model (Gerlach & Ely, 1980) can be viewed.

Depending on the nature of the instruction that will be designed, one of the above models or a combination of these models could be imitated. For this study, the Dick and Carry's systematic approach to designing that incorporates the major components common to all models, including analysis, design, development, and evaluation, was found to be most applicable.

Significance of the study and research questions

What can a science teacher do with the principles and knowledge of instructional design? By adopting and learning the principles of ID, science teachers can become better designers and create more efficient, relevant and effective instruction. They can use techniques of instructional design when developing laboratory instruction such as setting the objectives, setting the delivery strategy, forming the groups and setting up the experiment. Utilizing ID skills in the development of laboratory instruction cannot only facilitate the design of efficient instruction, but also instruction that is more effective and meaningful for the students. Becoming familiar with the principles and knowledge of the ID process or having a model as a guide may be beneficial for science teachers to use ID techniques. In this respect, using the model proposed in this study may facilitate the conduction of laboratory courses. For science teachers, the steps involved in the current systematic design may help them to sequence the components of a laboratory instruction.

Moreover, principles of ID can be leveraged to affect the quality change in the delivery of laboratory instruction to make teaching more effective, efficient, and appealing to learners. Because there is still a need for teachers to develop more effective laboratory courses, the present study developed a laboratory course design emerging from instructional design models and this design is validated through experts and science teachers' feedback. The developed model is expected to encourage (by directing teachers systematically in designing the course) and ease teachers' works in conducting laboratory activities. As a result, the overall purpose of this study in designing the laboratory instruction can be stated as to encourage teachers to conduct experiments systematically.

The major research questions in this study are:

1. Can a laboratory instruction model be imitated from one of the ID models?
2. What are the science teachers' current views and perspectives about components of a laboratory lesson?
3. What are the differences in teachers' views about science laboratory instructional design (SLID) model across their attributes, such as subject, gender, and type of school?

The overall flowchart of this study is given in Figure 1. All steps, with the exception of the last step (will be a used for the next research), are utilised in this study. As seen in Figure 1, the study starts with an introduction that includes a brief literature review about laboratory instruction and instructional design. Subsequently, the developed model is described. Then, teachers' views about the model are collected and finally the model is planned to be revised based on the teacher views. The effectiveness of this model is beyond the scope of this paper; however, the last step of the study may be of interest to other researchers.

SCIENCE LABORATORY INSTRUCTION DESIGN MODEL

Laboratory courses provide opportunities for students to learn procedural skills in a setting where they can observe, practice, explore and gain mastery through hands-on use of disciplinary tools and techniques. In order to ease achieving these goals, in this study, many ID models were analyzed and a new ID model for science laboratory instruction has been developed. The results of the analysis indicate that components of a laboratory course are well incorporated with Dick and Carey's ID model.

SLID's outline

The SLID model focuses on the achievement of the goals of an authentic laboratory work. An authentic laboratory course includes many interrelated components ranging from setting the goal to laboratory report. Some of the components have to be conducted in order to initiate the laboratory work. Depending on these initial steps the laboratory work has to be planned. After planning the necessary steps, the laboratory work is implemented. Once the laboratory work is executed the evaluation process takes place. The final activity is having a feedback system. It is important to note that the entire laboratory activity is assessed both during and after the laboratory work. All these steps and their sub-steps, including the relation between them is figured as a model in Figure 2. As seen in Figure 2, even though the SLID model is given a structure through Dick and Carey model, additionally it includes all components of the ADDIE model. In understanding the current model, following guidelines are necessary.

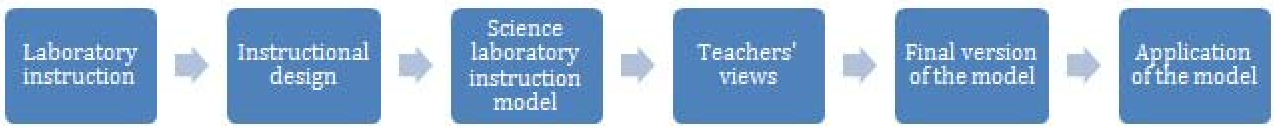

Figure 1. Flowchart of the study

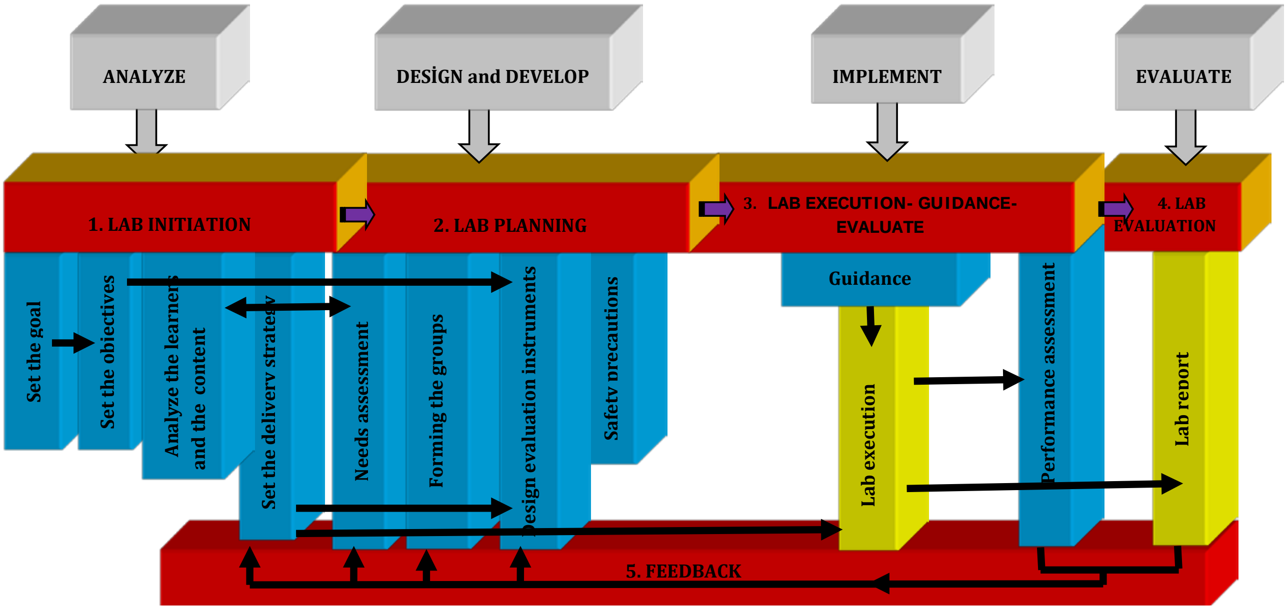

Figure 2. The SLID model

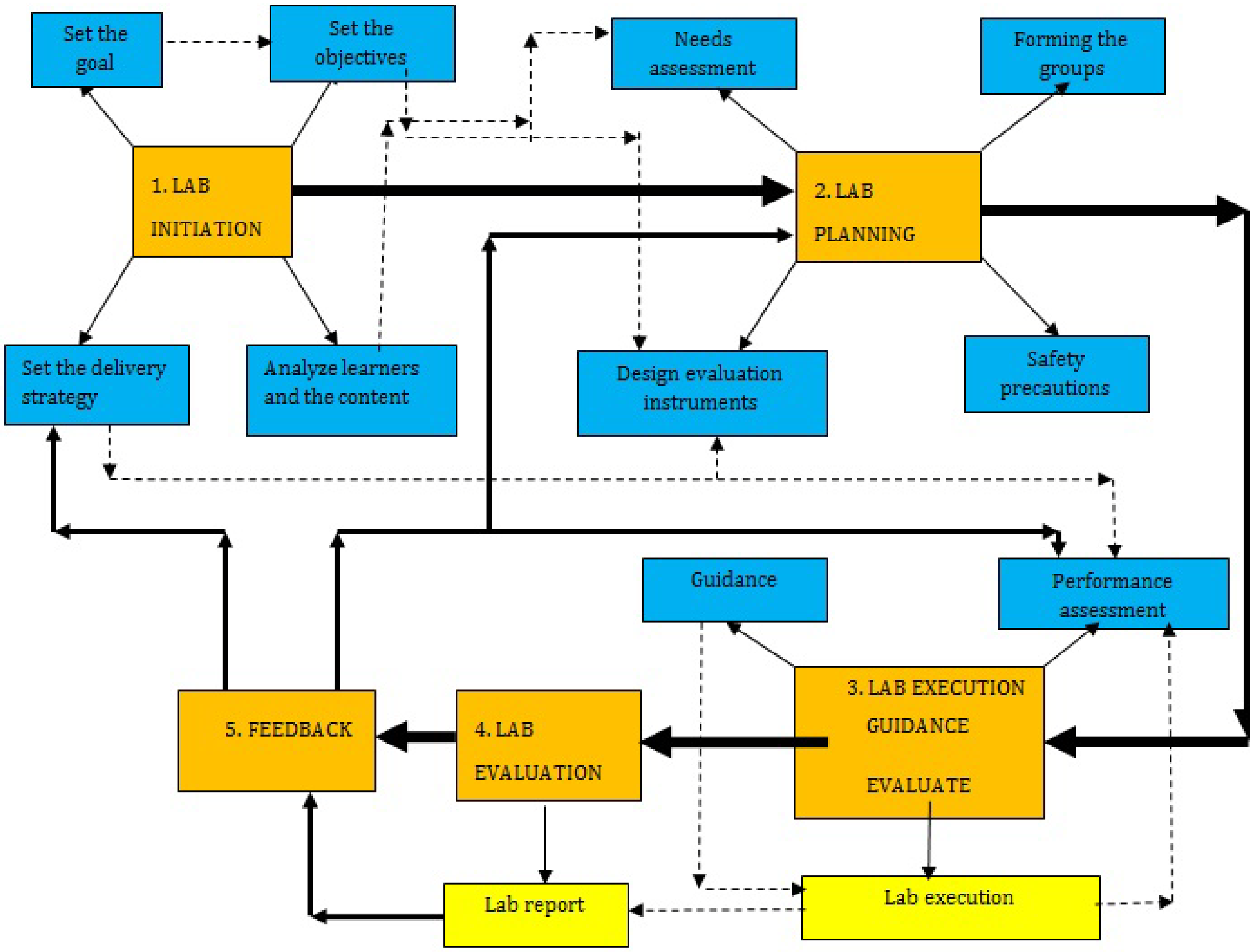

Figure 3. Second schema of SLID model

- This is a five step linear model.
- The blue boxes that touch the base receive feedback.
- Yellow boxes are executed by students.
- The height of the boxes has no meaning.
- The one-way arrows show the one-way dependence and two-way arrows show mutual dependence.
- The model shows the components that interact with each other.
- Every step is necessary in this model and the output of the prior steps, serves as input to the next steps.

The model also can be represented as shown in Figure 3. The model represented in Figure 2 and Figure 3 needs some more explanation. Namely, the organization and the relations between phases and sub-steps of SLID require further elaboration. In this model, initially setting the goal of laboratory work affects the determination of the objectives. This in turn affects the design of the evaluation instrument. This relationship is shown by one-way arrows in Figure 2. Similarly, a needs assessment for laboratory activity initially depends on the analysis of the learners and the content. On the other hand, needs assessment can help analyze learners and the content further. Thus, these two steps of SLID mutually affect each other and they are related to each other with a two-way arrow in Figure 2. Delivery strategy both influences the formation of the evaluation instrument (along with the objectives) and the laboratory execution (propose hypothesis, setting up the experiment, data collection and table, and the graphs). In this model guiding students in conducting the experiment and assessing their performances takes place during the laboratory execution. Once the laboratory is implemented students should prepare a laboratory report. The evaluation of laboratory report reveals the students' success/failure in the laboratory. Depending on the performance assessment during the experiment and evaluation of the laboratory report the instructor can revise the laboratory instruction. If laboratory instruction is not satisfactory, the model offers the steps "set the delivery strategy, needs assessment, forming the groups and design evaluation instruments" to take feedback.

SLID's phases

Lab initiation: Teaching in the laboratory is not a random activity. It must have clear purposes. Before beginning to plan a laboratory instruction, it is important to think about its goals and objectives. Moreover, before planning laboratory activity learners and the content should be analyzed. Furthermore, initiating laboratory activity in accordance with a learning theory brings the success.

Laboratory initiation phase in the SLID model coincides with the five initial steps (determine the instructional goal, analyze the instructional goal, analyze the learners and contents, write performance objectives and develop instructional strategy) of Dick and Carey's model, moreover, it overlaps with analyzing phase of ADDIE model. In SLID, the laboratory initiation phase consists of four sub-steps (set the goals, set the objectives, analyze learners and the content, set the delivery strategy).

Lab planning: This phase of SLID is partially specific to laboratory work. Forming the groups and safety precautions are the two sub-steps of this phase that are specific to laboratory instruction. Laboratory planning phase corresponds to the "assess needs to identify goals and develop assessment instruments" steps of Dick and Carey model. Moreover, this phase matches up to the design and develop phases of ADDIE model.

Lab execution-guidance-evaluate: This is one of the phases of SLID in which students are active. In this phase, laboratory work is executed under the guidance of the instructor, who assesses students' performances immediately. Since there is no implementation phase in Dick and Carey model this phase of SLID has no counterpart. Moreover, this phase matches up to the implement phase of ADDIE model.

Lab evaluation: In terms of students, a laboratory activity ends up with a laboratory report. During the laboratory implementation there is usually a time constraint and students prepare laboratory report at home. The laboratory report is usually used to evaluate students summatively. This phase of SLID coincides with "undertake summative evaluation" phase of Dick and Carey model and coincides with the evaluate phase of the ADDIE model.

Feedback: Once the laboratory work is done, by looking at performance assessment and laboratory reports, the instructor can revise some of the steps. In the SLID model the steps that receive feedback are "set the delivery strategy, needs assessment, forming the groups, design evaluation instruments". This phase of SLID matches up with the "revise instruction" phase of Dick and Carey model and this phase does not have a counterpart in the ADDIE model.

Relationships between SLID and Dick and Carey ID model

There are several main reasons behind implementing the Dick and Carey model. First, this model incorporates most of the major components common to all models including analysis, design, development, and evaluation. Second, it provides a systematic framework for conducting a laboratory work. Third, it enables breaking down the laboratory activity into steps. According to the goals of laboratory courses, the characteristic of division into sub-steps becomes beneficial for the planning of certain elements of content that influence the choice of elements like instructional objectives, analysing learners, and instructional conditions. The schema of Dick and Carey model is given in Figure 4.

In Dick and Carey model, the output of the first step (identifying instructional goals), serves as input to the second step (conducting instructional analysis and identifying entry behaviors). When completed, the outputs of these steps serve as input for the next step (writing performance objectives) and so on through all the phases. The entire instruction is tested and revised before full implementation and summative evaluation. The reason why Dick and Carey ID model best fits the laboratory course ID can be seen in Figure 5. The concurrence of steps in the Dick and Carey model and that of SLID is shown in that figure.

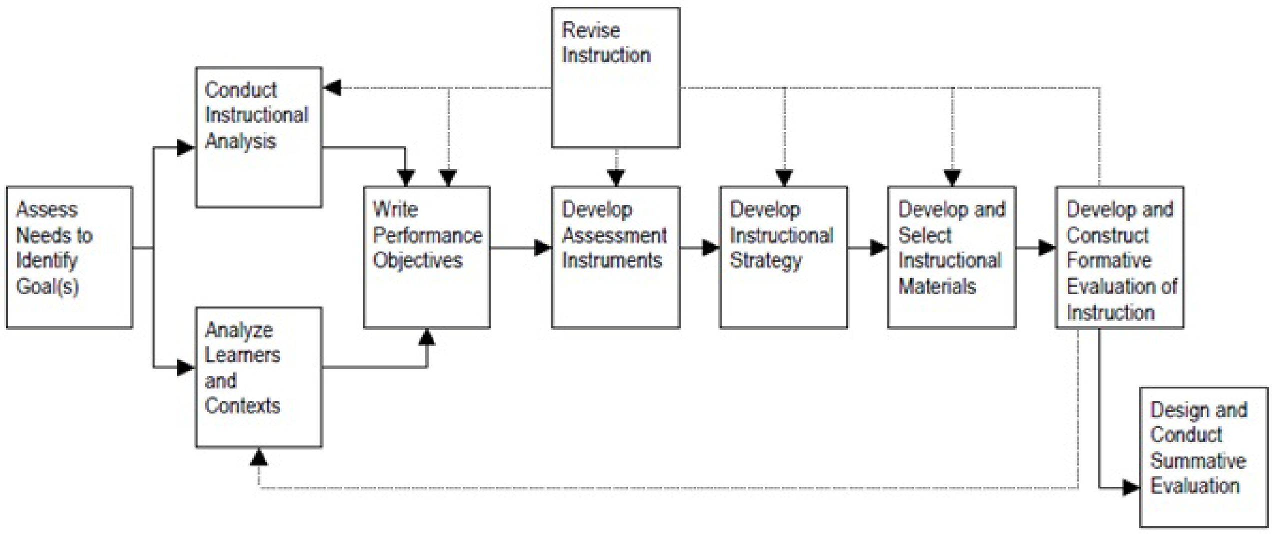

Figure 4. Dick and Carey ID model

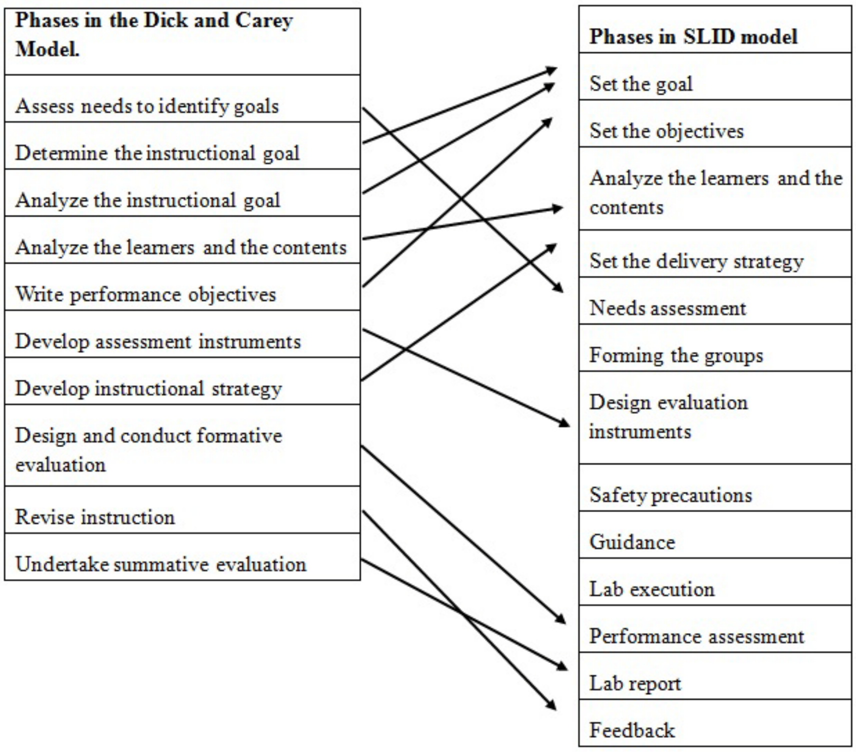

Figure 5. The concurrence of steps in the Dick and Carey model and that of SLID

Figure 5 shows that the Dick and Carey ID model mostly overlap with the SLID model. Some elements specific to laboratory instruction such as "forming the groups, safety precautions, guidance and lab execution" stands alone on the right-hand-side of the Figure 5. This is mostly because of the lack of ''implementation'' phase of Dick and Carey model.

THE USABILITY OF MODEL

To demonstrate the usability of the proposed laboratory instruction model, the opinion of science teachers was asked through a survey. The survey has 16 items (sub-steps of SLID) and each item consists of a number of opinion statements reflecting either a necessary or unnecessary attitude to the steps being added to SLID. Science teachers were asked to rate the items on a Likert scale of "absolutely necessary", "necessary", "no opinion", "unnecessary", "absolutely unnecessary". The survey had two categories of items:

a) Demographic items such as gender, subject and type of school.
b) How necessary/important it is to design each element of SLID?

34 high school science teachers (11 biology, 14 physics and 9 chemistry) from various parts of Turkey participated in this survey. The teachers were contacted through email and phone calls. The data collection instrument (in Microsoft excel format) was sent to teachers via email and the responses were received again via email. Participating teachers' teaching experiences range from 3 to 30 years (av. 19 years), laboratory courses they perform each semester range from 0 to 16 hours (av. 5 hours). 79% of the participant teachers were male and 21 % were female, of the 34 teachers 9 were from science high school and 25 were from Anatolia high school. Anatolian high schools are those that enroll students having moderate success in Turkish National Assessment Test executed among 8th grade students. On the other hand, science high schools are those that enroll students having the highest results on the same test. Moreover, 12 teachers were from public and 22 were from private

school. Thus, the usability of the developed model was assessed through teachers of various aspects.

Are steps of SLID model necessary?

SLID instructional design model consists of five consecutive phases and 16 sub-steps of these phases. The necessity of the phases and the relationship between these phases were validated through views and corrections of three experts and that of sub-steps - through 34 science teachers. Table 1 shows the means of scores of different groups of teachers about SLID's sub-steps on a five point Likert scale (absolutely necessary=5, necessary=4, no opinion=3, unnecessary=2 and absolutely unnecessary=1).

The mean of the items rated by the participant teachers on the basis of necessity was M=4.50. Setting the goal was rated the highest at M=4.95 followed by safety precautions (4.85). The importance of performance assessment was rated the lowest (4.12), the next lowest rated item was forming the groups (4.21). It is to be noted that though these items were the lowest on the survey, they were still rated between "absolutely necessary" and "necessary", showing that the teachers agreed on the importance of SLID's elements. Again, it is to be noted that all the items were scored above 4.00, which shows that on average, all items, were rated at least as necessary. The overall mean on the survey of all 16 items was extremely high (4.50).

Table 1. Survey results

Items	General mean	Biology	Physics	Chemistry	Male	Female	Science school	Anatolia school	Private school	Public school
Laboratory initiation										
Setting the goal	4,94	5,00	4,93	4,89	4,93	5,00	4,89	4,96	4,95	4,92
Setting the objectives	4,41	4,36	4,29	4,67	4,33	4,71	4,44	4,40	4,32	4,58
Analyse the learners and the contents	4,41	4,64	4,21	4,44	4,30	4,86	4,44	4,40	4,27	4,67
Set the delivery strategy	4,35	4,45	4,29	4,33	4,26	4,71	4,33	4,36	4,27	4,50
Laboratory planning										
Needs assessment	4,79	4,82	4,86	4,67	4,81	4,71	4,89	4,76	4,82	4,75
Forming the groups	4,21	4,36	4,14	4,11	4,11	4,57	4,11	4,24	4,14	4,33
Design evaluation instruments	4,35	4,36	4,43	4,22	4,26	4,71	4,33	4,36	4,27	4,50
Safety precautions	4,85	4,91	4,86	4,78	4,85	4,87	4,78	4,88	4,86	4,83
Laboratory execution -guidance -evaluate										
Guidance	4,53	4,73	4,50	4,33	4,44	4,86	4,67	4,48	4,36	4,83
Propose hypotheses	4,50	4,64	4,50	4,33	4,44	4,71	4,33	4,56	4,50	4,50
Setting up the experiment	4,65	4,91	4,36	4,78	4,63	4,71	4,56	4,68	4,64	4,67
Data collection and tables	4,50	4,45	4,43	4,67	4,44	4,71	4,67	4,44	4,50	4,50
The graphs	4,26	4,27	4,29	4,22	4,15	4,71	4,33	4,24	4,18	4,42
Analysis and interpretation of findings	4,53	4,45	4,50	4,67	4,48	4,71	4,78	4,44	4,50	4,58
Performance assessment	4,12	4,09	4,15	4,12	3,96	4,71	4,22	4,08	3,86	4,58
Laboratory evaluation										
Laboratory report	4,65	4,82	4,50	4,67	4,63	4,71	4,78	4,60	4,59	4,75
Feedback										
Feedback	4,41	4,55	4,29	4,44	4,37	4,56	4,67	4,32	4,32	4,58
Average	4,50	4,58	4,44	4,49	4,44	4,74	4,54	4,48	4,43	4,62

What are the differences in teachers' views about SLID across their subjects?

The SLID model was assessed by teachers from three areas of science instruction (biology, physics and chemistry). The mean of the items rated by biology, physics and chemistry teachers on the basis of importance was 4.58, 4.44 and 4.49 respectively. While biology teachers rated above the general average (4.50), physics and chemistry teachers rated below that average. While setting the goal was rated the highest (5.00, 4.93 and 4.89) by biology, physics and chemistry teachers respectively, performance assessment (4.09), forming the groups (4.14) and forming the groups (4.11) were rated the lowest, again respectively.

The differences in teachers' views about SLID across their subjects were also statistically examined. Since the normality in the data was not met, the nonparametric alternative to the one-way ANOVA (Kruskal-Wallis H) was conducted. The results of the Kruskal-Wallis H test showed that there was no statistically significant difference in teachers' views about SLID between the different subject teachers, $\chi 2(2) = 1.97$, $p = 0.37$, with a mean rank score of 20.82 for biology teachers, 15.29 for physics teachers and 16.89 chemistry teachers.

What are the differences in teachers' views about SLID across their gender?

To find out how the views of teachers differ across their gender, the gathered data was assessed descriptively and statistically. The mean of the items rated by male and female science teachers, on the basis of importance was 4.44 and 4.74 respectively. Male teachers rated the importance of setting the goals the highest at M=4.93 followed by the importance of safety precautions (4.85). Similarly female teachers rated the importance of setting the goals the highest at M=5.00 followed by the importance of safety precautions (4.87). The maximum gap between male and female teachers' views about SLID steps was about performance assessment. While male teachers rated this step at M= 3.96 female teachers rated it at M= 4.71.

The differences in teachers' views about SLID across their gender were also statistically examined. Since the distribution of scores for male and female teachers was not normally distributed, to compare the group differences, the Mann-Whitney U Test was used. The results of the test showed that there was no statistically significant difference between views of male and female teachers ($U = 49$, $p = 0.052$).

What are the differences in teachers' views about SLID across school type (science - Anatolia)?

When compared to other school types, the achievements of students of science high schools in Turkey are usually high, their teachers are relatively good at subject matter knowledge and they are expected to conduct more experiments during their instruction. Thus, the differences between science high school teachers and that of Anatolia high school teachers is noteworthy. The mean of the items rated by science high school and Anatolia high school teachers, on the basis of importance was M=4.54 and M= 4.48 respectively. When Table 1 is examined it is seen that on each step of the SLID model, teachers in both type of schools, have rated roughly similarly.

Statistically interpreting the difference between teachers' views, teaching in science high school and in Anatolia high school yielded no difference. Since the assumption of non-parametric tests was met, the Mann-Whitney U Test was used to assess the mean differences. The results showed that the difference between the means of both groups of teachers was not statistically significant (U=100,5 and p=0.64).

What are the differences in teachers' views about SLID across school type (private- public)?

In terms of some aspects, such as the quality of teachers and laboratory equipment, the teachers in private and public schools differ. This difference may affect their views about the SLID model. The mean of the items rated by science high school and Anatolia high school teachers, on the basis of importance was M= 4.43 and M= 4.62 respectively. While the mean of scores of private schools is below the general average, that of public is above that average. The obvious difference between private and public school teachers' views appear on the performance assessment (3.86 and 4.58) and the graphs (4.18 and 4.42).

The statistical analysis on the group means showed that there was no difference on the views of private and public school teachers. The Mann-Whitney U Test was used to come up to this result (U=96,5 and p=0.20).

Revised laboratory instructional design model

SLID was developed to be put at the disposal of science teachers. Depending on their views revision intended, however, as seen in Table 1 all sub-steps of SLID are scored above 4.00. Moreover, above analysis showed that there were no conflicts between the views of any groups of teachers (male-female, private-public and so on). Thus, based on the feedback received after survey, there was no need in revising the model.

CONCLUSION AND IMPLICATOINS

This paper has described a laboratory instructional model emerged from Dick and Carey ID model. Their systematic approach that represents the structure and sequence of learning activities is used for developing this science laboratory instruction ID model. In addition, the usability of the model was tested and it was found that the science teachers agreed on the importance or the necessity of the model. It indicates that the Dick and Carey ID model was imitated successfully in the design and development of SLID. The applied survey confirmed that the combination of SLID elements, such as setting the goal, safety precautions, laboratory execution and laboratory report, together with a follow-up rapid feedback system, are core aspects of a powerful environment for laboratory courses.

Through this study, the necessity of SLID's sub-steps were once again stressed by the biology, physics and chemistry teachers. Also, it was interesting to note the consistent ratings of the steps of SLID by various groups of teachers. This research has implications for the design and conduction of laboratory instruction. The important phases and elements of a laboratory activity have been pointed out, and the importance of alignment between these instructional elements has to be kept in mind in the design of laboratory instruction. Using the SLID model in the laboratory instruction is expected to save much time and make the instructional material more effective compared to just using the regular approach. Furthermore, the SLID model is a skeleton for a laboratory instruction, which would prove useful to inexperienced science teachers in the design of laboratory work. SLID can guide teachers in designing laboratory activity in deciding where to start, how to continue, how to end and how to revise the instruction. It is concluded, therefore, that SLID provides a well-structured model to inspire science teachers to design a systematic laboratory-learning environment.

Future work related to this research should be in two directions: searching the effectiveness of the model and offering new models or changes in the current model. In relation to the first point, research should be aimed at comparing regular laboratory instruction and systematic instruction through SLID. As for the second, efforts should be focused on the revisions in the SLID model or develop new models by referring to SLID.

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