

Guidelines and Templates for Planning, Conducting and Reporting Educational Technology Research

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Abstract – Educational Technology (ET) research encompasses a wide range of areas, including the development of technology tools for learning and teaching, pedagogies for technology enhanced learning, and use of ICT-based materials or tools for learning. The interdisciplinary nature of ET leads to a wide variation in the focus and quality of research articles. Hence there is a need for guidelines for planning, conducting and reporting ET research studies. Such guidelines are also useful to instructors, as they are often well-positioned to carry out applied ET research studies. This article is a mini-tutorial that provides guidelines and templates to conduct ET research studies. The emphasis of this tutorial is on criteria that reviewers use to evaluate research papers and how the criteria can be met. This tutorial is designed to be used with an accompanying set of templates that we have created. The templates offer scaffolds to the researcher during various stages of research, so that reviewers' criteria are effectively addressed.

Keywords: Educational technology, research design, review criteria, guidelines

I. INTRODUCTION

This article is a mini-tutorial on carrying out Educational Technology (ET) research studies. It provides guidelines for planning, conducting and reporting an ET research study. The focus of this tutorial is on criteria that reviewers and program committees use to evaluate a research paper. This tutorial is accompanied by a set of templates to be used during the different stages of the research process [1]. The templates provide a bridge between activities that researchers do at various stages of research, and the criteria that they should pay attention to while doing those activities. We expect that the use of these guidelines and templates will enable ET researchers to design effective studies.

ET research encompasses a wide range of areas, including the development of technology tools for learning and teaching, use of tools to widen access of education, pedagogies for technology enhanced learning, use of technology-based learning materials for learning of specific domains, and so on [2]. The scope of this mini-tutorial is specific to teaching-learning interventions that involve either (i) the use of a technology-based instructional strategy, or (ii) the development of an ET tool.

The primary target audience for this tutorial is in-service instructors, who are in a position to conduct action research in their classes. Many instructors have ideas on using an instructional strategy or technology tool for improving some aspect of their teaching practice. Their students provide them

with a 'laboratory' to conduct research studies on the effectiveness of these interventions. However, many such instructors are not formally trained in conducting ET research and writing research papers. This tutorial is a step towards assisting such instructors to become "practitioner-researchers" in ET.

The secondary target audience for this tutorial is researchers who focus on the development of new ET tools. Often researchers focus largely on the development details of their tools and pay little attention to rigorously investigating the usability and usefulness [3] of their tool in practical educational settings. This tutorial is a step towards assisting such researchers to become "researcher-practitioners" in ET.

A. Focus of this mini-tutorial

Several researchers, in a variety of scientific disciplines, have offered advice on conducting research and writing papers. A typical research process involves stages such as coming up with an idea, analyzing existing related work, identifying a gap, working out the solution, conducting the study, making claims and establishing validity of claims [4]. The researcher reports the research findings in a paper and submits it to a journal or conference.

Reviewers and program committees evaluate the paper on the basis of criteria, such as novelty of idea, positioning with respect to related work, soundness of procedure, and evidence of claims [5]. Two excellent articles on writing effective papers that offer advice from the perspective of a reviewer are: i) A detailed report by Shaw [6] on how to write software engineering papers, including common concerns of program committees and how to address them. ii) A succinct article by Keshav [7] that elegantly explains what effective papers in computer systems should contain. Jones [8] provides guidelines that ensure clarity and focus in the research process using the approach: "Idea → Write paper → Do research". While the domain of these articles is not ET, the guidelines in them are applicable to a broad set of fields including ET.

In order to meet reviewers' criteria in the research paper, it is important to keep these criteria in mind during the research process itself. In this tutorial, we describe the criteria that reviewers expect, and list questions that they typically ask to evaluate if the criteria are addressed. We suggest how the researcher may address these questions. To answer these questions in detail, our templates provide scaffolds that researchers can use during the planning, conducting and reporting stages of their work. While this tutorial is short, the templates [1] are more comprehensive, and we encourage the reader to download and use them.

II. TEMPLATES

Similar to research in many other disciplines, the process of educational technology research includes stages of planning, conducting and reporting. We have created templates that guide the researcher in each stage of their work. There are four templates:

1. Idea Proposal Template (IPT)
2. Study Planning Template (SPT)
3. Paper Planning Template (PPT)
4. Paper Writing Template (PWT)

Each template contains question-prompts that act as scaffolds for a researcher to conduct research and write a paper that meets reviewers' criteria. The templates also contain examples from published research studies which demonstrate how to address the criteria. (These criteria are elaborated in Section III.) Fig. 1 below shows a mapping between the stages of research, the templates to be used in each stage, and the criteria addressed in each template.

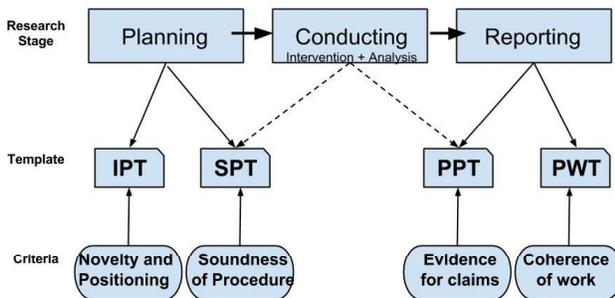


Fig.1. Mapping between stages of research, templates, and review criteria

III. ELABORATION OF REVIEW CRITERIA

Keeping in line with a tutorial format, in this section we use the personal, direct form of address (“you”, “your paper”) instead of the more formal third person reference (“the researcher”).

A reviewer looks for evidence that your paper contains:

- **Novelty.** What new knowledge has your research contributed, and how can this new knowledge be applied elsewhere.
- **Positioning.** Arguments for why your work is required in the light of prior published research, and how your work advances the state of art.
- **Soundness of procedure.** Details which show that the steps of the solution have been implemented systematically.
- **Evidence of claims.** Evidence such as data, analysis, examples and feasibility studies which show that the solution works as claimed.
- **Coherence.** Consistency between problem to be solved, solution approach, results, and claim.

The reviewer asks several questions to evaluate how well each criterion is met. A good research paper should contain answers to these questions, indicating what and how the researcher has accomplished. Hence it is important to pay attention to these questions at the time of planning and conducting the research itself. The templates contain further guidelines and examples on how to answer these questions.

In the following subsections (A-F), we examine each criterion and list questions that reviewers typically ask to evaluate if the criterion is met. We suggest how you can go about addressing these questions in the context of ET papers within the scope described in the Introduction. While these questions are not exhaustive, they constitute a minimal set of questions that are necessary to be answered. We recommend that you use these questions as a checklist to ensure that your paper meets the reviewers' criteria.

A. Before you begin

One of the first questions you should clearly be able to answer is:

- What is the problem you are trying to solve?

You have to state who will benefit by solving the problem, and in what way. For example, if your work is on technology-based instructional strategies, is the problem you have set out to solve, related to students or teachers? If students, then state if it is about improving students' learning, or engagement. If you are developing a tool, say who its target users are, and what is the problem faced by these users that your tool will solve.

You should then be able to answer:

- Why is the problem important?

You should be able to show (using data) or argue (based on literature) that the problem exists for your target population or users. You should be able to explain why it is important to solve the problem, and why the solution matters.

B. Novelty

Once you have determined which problem you intend to work on, you should be able to explain:

- What, precisely, is your idea to solve the problem?

If your work is on an instructional strategy, state: What will you do? What will students do? What do you believe will ‘improve’? If you are developing a tool, say: What will the tool do? What inputs does it require? What outputs will it produce? What is a user of the tool expected to do?

You should be able to argue that your idea to solve the problem is novel. Reviewers will look either for new knowledge (ideas that have not been reported so far in published work) or for valuable confirmation of existing knowledge. Thus, you should be able to explain in what manner your idea is novel. You will need to answer the following question:

- Where is the novelty in your idea?

If your work is on an instructional strategy, did you devise a new strategy? Or, did you adapt an existing strategy to a new domain? If you have used an existing technology or a known strategy, you have to be able to show how your new result is different, or better than existing results. If you are developing a tool, did you develop a new technology tool for teaching or learning? Or, did you adapt existing technology for a new purpose? Answers to these questions must be clearly stated in your paper.

Reviewers expect your research paper to contain an interesting and novel solution which addresses the problem you set out to solve. Not all ideas are acceptable. The following are some examples of ideas which are not acceptable as ET research:

- *Use of a tool in a routine manner is not research.* For example, using Moodle to upload course materials and homework. To be considered as an acceptable research paper, you need to implement an innovative method of using the tool to achieve a teaching- learning goal. You need to show how your work is different or better than what has been done before in related published work.
- *Development of ICT-based instructional material is not research.* For example, developing animations for a course. To be considered as an acceptable research paper, you need evidence from a rigorous study that your idea has indeed solved the problem you intended to solve. You need to show that your material has resulted in improvement of a certain metric among your target users, such as student performance or engagement, as compared to what has been reported in related published work.
- *Development of a new tool is not a research.* For example, tools to automate a task in an educational scenario, or mobile-based applications for a topic. To be considered as an acceptable research paper, you need to not only give details of the design of the tool but also show that the tool has resulted in the improvement in some metric among your target users, such as student performance or engagement, or teachers' efficiency.

C. Positioning

An important aspect you should consider in the research planning stage is prior work related to your research. The reviewer seeks evidence for two seemingly contradictory points: a) Your work builds on prior related work and b) Your work is different or better than related prior work. To be able to provide this evidence, you should be able to answer the following questions.

- Is your solution based on the application of appropriate theory and principles?

You should be able to show that your work is based on the application of established educational theories. Explain the established learning principles on which the design of your technology-based solution or instructional strategy is based.

Even if you are developing a technology tool, its core functionality or the logic of your solution should be based on an appropriate educational theory.

- Has your paper analyzed related prior work?

You should refer to other published papers that have addressed a problem similar to yours, as well as papers that have a solution approach similar to yours.

- Have you clearly brought out the gaps in related work?

You should analyze the papers you have referred to, compare them, and bring out the gaps in existing work. If you are able to identify the gaps, you will have established that there is a need for your research.

- Have you explained the relation of your solution to related prior work?

You should be able to show how your solution is different or better than existing work. For example, does your solution address any of the gaps above? Does it extend the solution in existing work? Does your work provide an alternative solution? Essentially, answering any of these questions clearly is a way of establishing the novelty of your work. Thus the process of addressing questions related to novelty and positioning is iterative.

D. Soundness of Procedure

The reviewer looks for evidence that you have implemented the steps of the solution carefully. You need to provide sufficient relevant details of your treatment such that it can be replicated. However, while these details are necessary, they are not sufficient to establish that your solution solves the problem you set out to solve. For example, giving a long report of the details of your course and showing results of test marks is not a research paper. Similarly, giving a long report of the implementation details of your tool development process or describing its every feature, is not a research paper.

Instead, you need to conduct a systematic study to establish that your solution solves the problem you set out to solve. You need to make appropriate measurements to show that your instructional strategy or tool works for the target population or users. Commonly used metrics to evaluate the effectiveness of instructional strategies are improvement in student performance (before and after the treatment), students' engagement, students' perceptions of their learning or engagement, and instructors' perceptions. Each metric needs to be measured by validated instruments. For example, improvement in students' performance can be measured by pre- and post-tests, and students' perceptions can be measured by carefully constructed survey questionnaires. Common metrics used to evaluate ET tools are usefulness, that is how well does the tool fulfil its intended purpose to solve the problem, and usability, that is how easy is it for users to accomplish tasks using the various features of the tool.

If your research is oriented towards instructional strategies, you have to specify all aspects of your research design, which includes: sample, measurements, instruments, treatment procedure and data analysis technique. The reviewer looks for detailed answers to the questions below.

- What is the sample? Have you justified why it is suitable for the problem?
- If you plan to do a controlled study involving two or more groups, how is the equivalence between groups established?
- What will you measure in your study? How can you justify that these measurements are suitable for the problem?
- What instruments will you use for the measurements? How can you establish that they are valid and reliable?
- Have you described the treatment in sufficient detail that the study can be replicated? (details such as the setup, sequence and duration of activities)
- Which data analysis technique have you chosen (for example, which statistical test)? Why is it appropriate to establish that the solution works?

If your research is oriented towards technology-tools, you have to give specifics of how well your tool addresses the problem, and describe details of your trials to evaluate the tool. The reviewer looks for detailed answers to questions such as:

- Does your solution have all the features required to solve the problem?
- Have you shown the test-cases for which your solution works correctly? Have you justified that these test-cases are suitable for the problem?
- Have you done pilot experiments to show that users can indeed use your solution? You have to show results for the usability of your solution as well as its usefulness.
- Have you compared your solution with similar existing solutions? Comparing with existing solutions is analogous to comparing with a control group. Even if you are not able to carry out comparative testing, you should provide at least a feature-level comparison with arguments for why your solution is better.
- Have you done experiments of using your solution in an actual deployment scenario?

E. Evidence of Claims

The reviewer looks for evidence that your solution idea works, not only in your instance but also for other instances similar to yours. You have to provide details of evaluation such that your claim is believable. You should be able to answer the following questions:

- How well does your result support your claim?
- Is each claim substantiated by your data and analysis?
- How can you establish that your result is statistically valid? Generalizable?

F. Coherence

The reviewer looks for coherence across all the stages of your research. You should be able to answer the following questions:

- Is your treatment (solution) appropriate for your research goal/problem?
- Are your measurements appropriate to establish the validity of your solution?
- Have you given due emphasis to the positioning and evidence of your work?

IV. CONCLUSION

This mini-tutorial is an overview of what questions an ET researcher should ask during the process of research, so that the product (the research paper) is likely to meet the reviewers' evaluation criteria. For more detailed guidelines and examples for each stage of research, we encourage readers to use this tutorial along with the templates [1].

The scope of this tutorial is specific to teaching-learning interventions, in the form of technology-based instructional strategies or development of tools to aid specific teaching-learning problems. However, this tutorial is not a guarantee get your paper accepted. We do not claim that the contents of this tutorial are novel or complete. On the other hand, we believe that the contents of this tutorial will be useful to a wide range of researchers to design stronger research studies and report their work more effectively.

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