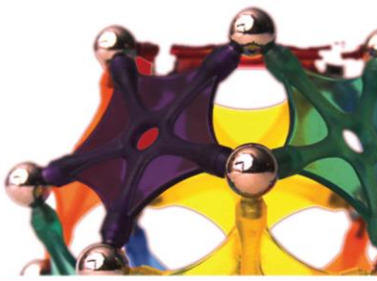
NCTI National Center for Technology Innovation



Assistive Technology Research Matters

ATiA Assistive Technology Industry Association

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About the Authors

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About the National Center for Technology Innovation

Established in 2001, the National Center for Technology Innovation (NCTI) advances learning opportunities for all students, with a special focus on students with disabilities, by fostering technology innovation. NCTI offers technical assistance to facilitate growth and sustainability of learning and assistive technologies. The Center is funded by the Office of Special Education Programs at the U.S. Department of Education and is located at the American Institutes for Research in Washington, DC. The contents of this brief were developed under a grant (PR/Award #H327Z060003) from the U.S. Department of Education. However, these contents do not necessarily represent the policy of the U.S. Department of Education, and you should not assume endorsement by the Federal Government.

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ASSISTIVE TECHNOLOGY RESEARCH MATTERS

NCTI and ATIA have teamed up to develop a research primer for AT developers, manufacturers, and vendors. Both an online guide and a series of webinars with AT industry leaders, these resources will get you up to speed on research in 2011.

Introduction

This primer lays out several research designs that may be appropriate for demonstrating the effectiveness of educational and assistive technology tools. These sections are brief synopses of the parameters of each design, and links to resources are included throughout for those who want to learn more. The text is meant to be explored interactively, with hyperlinks back and forth throughout the primer, the NCTI website, and the other web resources. The reader is also referred regularly to other NCTI resources that address development issues in earlier steps toward commercialization of a product.

What's Inside:

Research Designs

- Explore six research designs: usability, market, case study, single subject, quasi-experimental, and experimental
- Consider the "so what" and "for whom" questions for each design

Key Concepts

- Understand validity and reliability, as well as ethical considerations
- Learn about Institutional Review Boards (IRBs) and the approval process

Resources

- Find tools and suggestions for reaching out to networks for researchers, working with professional librarians, and sources of funding

Why Use Research?

How can educational and assistive technology developers, manufacturers, and vendors position themselves to participate in credible research and stay current with new research in the field? Beyond the question of whether a product "works," consumers and purchasers are now more focused on whether it improves academic achievement, heightens engagement with the curriculum, and can be integrated into the existing learning and IT environment. Since the 2001 passage of the federal No Child Left Behind Act, which mandates that schools make purchases based on research evidence, those responsible for procurement in schools and districts, including product review teams, have been more likely to ask about the quality of research behind products under consideration. Therefore, working to integrate research into product development and delivery is an effective means of differentiating your products and service.

RESEARCH DESIGNS

Usability

Usability studies are aimed at determining the ease of use of a particular device, software, or technology. They are conducted in order to inform product developers of barriers to user interface and design errors. Usability studies take place in controlled conditions or natural settings, where researchers can observe subjects attempting to use a device or technology for its intended purpose. Many factors are taken into account when measuring usability, including: the ease in which novice users can accomplish basic tasks, the length of time it takes users to accomplish basic tasks, the types of mistakes users make and how frequently they make them, and the attitudes users take towards the technology. The technology's compatibility with various assistive devices, features, and software programs is also a consideration.

What are the benefits of conducting a usability study?

Usability studies let product developers understand barriers to user interface and design errors before a product goes onto the market. By identifying these barriers early, developers have the opportunity to rectify them. Properly addressing design flaws before the product goes into production or to the market saves time and money, increases customer satisfaction with the product and thereby increases sales and revenues. By building with the widest population of users in mind and ensuring universal access features and compatibility with assistive devices, features, and software, the product can also meet more consumer needs.

When should I conduct a usability study?

Usability studies allow product developers the chance to see how the intended customers will interact with their product. By doing so, these studies can help developers understand potential barriers their customers would experience after purchasing their product. For assistive technologies this is particularly important. Some examples of usability questions are:

- How easy is it for people to use our product?
- How easy is it for caregivers or service providers to use and integrate our product into a natural setting?
- What mistakes do people make when using our product?
- What problems occur when people use our product?

Usability study questions are answered through direct observation, interviews, surveys, and questionnaires. It is critical to have real users, representative of your consumer base, involved in the usability tests. Choose testers wisely so that you get the widest possible slice of your market. For example, if you plan to market a magnifying software tool to both the blind/low vision education community and to the elderly, then you need to have both consumer groups in your study.

What are the resources needed to conduct a usability study?

Unlike some rigorous academic forms of research, usability studies can be—and in fact ought to be—conducted by people within your organization. Often in research, it is important to get an outside organization to conduct studies in order to prevent bias or the appearance of bias. With usability studies, however, this is not a concern. The prime purpose of a usability study is not to determine that a product works, but rather what design problems there may be with a product, particularly in

the early build stages. Having people who are involved in the design process help implement the usability study is beneficial, since it is important that the information gained from the usability study be directly understood by the design team.

Usability studies are relatively inexpensive. Researchers are encouraged to use no more than five study participants for each round of usability testing. Furthermore, testing itself takes a short period of time to complete. However, as discussed above, it is important that different target audience segments are included as testers, so a thorough study may involve multiple rounds of users.

Elements of a usability study

Study participant recruitment

Study participants should be recruited from the group of consumers to whom you will be marketing your product. With usability studies, it is important that the study participants enter into the study with the same amount of knowledge that the average consumer would have. That is, using members of the design team as study participants would give you flawed results, since they would have prior experience with the product. Similarly, using study participants who have less experience with your type of technology than the average consumer would give you flawed results as well.

When conducting a usability study, create a protocol or scenario to have study participants attempt to use your product for appropriate, natural tasks. It is important that the study itself best mirrors how your likely customers will use your product in the natural setting.

Remember, usability studies are aimed at pointing product designers to the barriers to use and the product design errors, not to the solutions of those problems. While developing possible solutions may not be difficult, getting the right solution is necessary. It is important to conduct usability tests on the redesigned product in order to ensure that you have solved the problem, and that you haven't made it worse, or created additional problems. When conducting usability tests on a redesigned product or version, it is important to use a different group of consumers as your study participants in order to get a fresh perspective.

Article: Seven Common Usability Testing Mistakes

Observation data

Gathering data from observing study participants is an important part of a usability study. Often, study participants are placed in realistic situations where they are asked to perform specific tasks using the product that is being tested. People administering the usability study observe and take notes on how well the study participants are performing, on how long it takes for them to complete specific tasks, and on any difficulties the participants appear to be having. Logging software that records user paths and click patterns can be installed to provide additional data from a user test. Having participants think aloud or talk through what they are doing provides insight into their planned and executed actions. Take the opportunity while you have consumers with you to ask, "Can you think of a different or better way you could use this device?" Consumers may surprise you with setting realities and applications.

Survey data/questionnaires

Open-ended questions (e.g., "What difficulties, if any, did you have in completing task A?") can be qualitatively analyzed by looking at trends and themes in the data or tallying up the most frequent topics across all survey respondents.

Examples and additional resources

Further resources

See these sites for further information on usability testing and design:

User Interface Engineering

Usability Testing: How to plan, design, and conduct effective tests

Usability.gov

Useit.com (Jakob Nielsen)

A real world example

My School Day Online. With an NCTI *Tech in the Works* award, this team compared the ease of use for students and teachers of Bridge Multimedia's My School Day Online scheduler to ease of use of Microsoft's Outlook scheduler. The study was conducted on site at the Tennessee School for the Blind, and findings and user feedback informed ongoing technology development.

Market Research

Market research is aimed at determining the needs and expectations of consumers (end users or purchasers) in different marketplaces. A critical component of conducting business, market research is meant to guide what businesses develop and how they market their products. There are two types of market research: primary research and secondary research. Primary research consists of organizations conducting first-hand research to solve specific problems, determine consumer needs, or discover specific opportunities. Primary research is conducted by the organization or is contracted out to a market research firm. Secondary research consists of an organization reviewing pre-existing data and/or information which may help the organization understand specific problems, determine consumer needs, or discover specific opportunities.

What are the benefits of conducting market research?

Both primary and secondary research aim to help organizations better understand the marketplace and both can be beneficial to product development, design, and the marketing of a new product. Market research may allow organizations and entrepreneurs to identify specific needs of consumers and to design their products to meet those needs. Furthermore, market research may allow organizations and entrepreneurs to identify new markets created by consumer needs that are not being met by an existing product. Other benefits of market research include better understanding of natural settings and implementation environments, evidence-based decision making, and minimizing risk as you get into a new market or product line.

When should I conduct market research?

Market research can answer questions related to consumer needs, as well as what other organizations are doing to meet those needs. Some examples of market research questions are:

- What are your **priorities** for this need and which funds would be used to purchase them? What obstacles do you need to address before this decision can be ratified?
- Are the **purchase decisions** made by classroom or school-based teams or are they district-wide decisions? What mandates and constraints are directing your decisions? Who else is involved in making this purchasing decision and what does the purchase process look like?
- What is the **timing** process that the team goes through in order to make this decision?

Market research questions take the form of interviews, surveys, questionnaires, and analysis of sales and markets. The following section focuses on designing interviews, surveys, and questionnaires.

What are the resources needed to conduct market research?

Market research requires both business and basic research skills. Since primary research often uses tools such as surveys and interviews, it is important that those conducting market research are trained in survey development and design, interview protocol development, conducting interviews, and interpretation of survey and/or interview results. Secondary research requires less instrument development, but it does require the ability to locate and interpret pre-existing primary research results. While many professionals and entrepreneurs have these abilities, training is recommended on survey development, conducting interviews, and interpreting findings for your business.

See training resources at:

Education-Portal.com

Analyzing, Interpreting, and Reporting Basic Research Results

Since the goal of market research is to determine consumer needs in order to develop or improve a product that will be successful, it is necessary that the costs of market research are affordable. While some large organizations can afford to conduct large scale primary market research, perhaps hiring an outside firm for additional credibility, most organizations find financial constraints are a leading barrier to conducting market research. Organizations can make use of low-cost web-based tools to conduct market research when applicable. For example, electronic surveys are an inexpensive way to gather information from many consumers. Other web-based tools, such as consumer forums and discussion boards, are also recommended. Time constraints are flexible based on the goals of the research (quick product survey or in-depth inquiry across many stakeholders).

Elements of market research

Study participant recruitment

Study participants can be recruited from the group of consumers to whom you are marketing. However, a common pitfall is reaching out only to current customers; be sure you are making efforts to reach **likely** customers as well. Often organizations have pre-existing relationships with many of their consumers, and using your organization's existing connections to recruit study participants is recommended. Beyond that, social media and crowd sourcing, as well as consumer forums and discussion boards, are useful tools in recruiting study participants. Additional options include collaborating with other organizations that may serve your target audience (such as non-profit organizations, professional associations, school districts, etc.), or even cold calling people you know to be potential consumers of your product. Market research does not just have to take place at one stage in the product development process—it can inform all stages of product development.

Challenges to conducting high quality market research include the potential to reach only existing customers, not potential customers; low response rates on surveys that lead to skewed sample results; and "group think" or socially expected responses shared in focus groups. Additionally, researchers should avoid asking poorly conceived questions that do not lead to reflective answers; conducting an insufficient analysis of data leading to false or hasty conclusions; or gathering an insufficiently representative sample of respondents. These challenges can be addressed with thoughtful planning and reality checking.

See more resources at:

Market Research.com

This site offers a collection of market research reports and specialists' knowledge on the publishers and reports in respective industries.

Export.gov

This organization helps U.S. companies export their products by using market research to screen and assess potential target markets before developing an export plan.

Inc. Magazine Research Primer

This site holds a compilation of market research articles, starting with an explanation of market research and the reason it is necessary, and including many topics such as introducing a new product, demographic research, bootstrapping, and common mistakes made.

Marketing Research Association

This is a self-managed, non-profit organization which provides services that enable market researchers to develop professionally, gain insight on industry trends, and network and stay connected with fellow researchers.

Survey data

Survey data can be quantitatively or qualitatively analyzed, depending on the type of survey question. Survey questions with scaled answers (e.g., Strongly Agree, Agree, Disagree, Strongly Disagree) can give snapshots of consumers' attitudes and preferences by looking at basic frequencies (percentages). Open-ended questions (e.g., What are your top five needs?) can be qualitatively analyzed by looking at trends and themes in the data, or by tallying up the most frequent topics across all survey respondents. For more resources on analyzing survey data, see Analysing Survey Data.

Interview and focus group data

Interview and focus group data can be analyzed either manually or by using qualitative data software, such as Atlas.ti (for a list of qualitative data software, see http://www.antiochne.edu/cp/qr/software.cfm). Regardless of whether this is done manually or by using analysis software, the purpose of interview and focus group analysis is to find the major themes mentioned in the interviews/focus groups.

Examples and additional resources

Real world example

Listen to Cheryl Volkman, CEO Emeritus of AbleNet, Inc., describe the marketing research AbleNet conducted when they realized that their client base was changing. NCTI assisted with the data analysis on the AbleNet, Inc. interview transcripts to produce the findings, published as the Consumer Guide.

Published articles using market research

Overton, C., Volkman, C., Silver-Pacuilla, H., & Gray, T. (2008). Understanding Consumer Needs Through Market Research. Assistive Technology Outcomes and Benefits, 5(1), 4-18.

Secondary resources

The Software and Information Industry Association compiles domestic and international trends and sales figures for software and technology. See a recent report at http://www.siia.net/estore/globecon-08.pdf.

The World Bank sponsored a global look at how accessible technologies could benefit the developing world, and hosts an ongoing blog on accessible education. Two reports looks at the value of universally designed technology:http://www.thelancetglobalhealthnetwork.com/wp-content/uploads/Disability-REV-3.pdf and http://siteresources.worldbank.org/INTGEP2008/Resources/complete-report.pdf.

The University of Buffalo's Rehabilitation Engineering Research Center on Technology Transfer created Assistive Technology Industry Profiles drawn from extensive stakeholder roundtables and economic research. See:

- Industry Profile on Wheeled Mobility, Bauer, S.M., Buning, M.E. (Eds.) (2009)

- Industry Profile on Education Technology: Learning Disabilities Technologies and Markets, Strobel, W.A., Arthanat, S., Fossa, J., Mistrett, S., and Brace, J., (2009)
- Industry Profile on Visual Impairment, Strobel, W.A., Fossa, J.L., Panchura, C.A., Beaver, K.A., Westbrook, J.M. (2003)

Deloitte is a global business advisory organization. Their website is full of resources for analyzing business opportunities and trends. See the Telecommunications Media and Technology (TMT) Group web page.

The Entertainment Software Association is one of the largest industry associations of gaming and related media. They conduct and analyze surveys and produce industry trends. See for example, Siwek, S. E. (2007). Video Games in the 21st century: Economic contributions of the U.S. entertainment software industry.

Case Study

A case study is a detailed investigation of a single individual or group. Case studies can be qualitative or quantitative in nature, and often combine elements of both. The defining feature of a case study is its holistic approach—it aims to capture all of the details of a particular individual or group (a small group, classroom, or even a school), which are relevant to the purpose of the study, within a real life context[1]. To do this, case studies rely on multiple sources of data; including interviews, direct observation, video and audio tapes, internal documents, and artifacts. The final report or write-up is a narrative with thick, rich descriptions. Increasingly, case studies are being presented as multimedia packages, such as a documentary, to showcase the uniqueness and complexities of the context.

Case studies can be used for descriptive, explanatory, or exploratory purposes (Yin, 1993)[2]. For any of these purposes, there are two distinct case study designs: single-case study design and multiple-case study design. Single-case studies are just that, an examination of one individual or group. In choosing a case, researchers may purposely select atypical, or outlier, cases. An outlier case tends to yield more information than average cases. Multiple-case studies use replication, which is the deliberate process of choosing cases that are likely to show similar results. This helps to examine how generalizable the findings may be. See section on validity.

What are the benefits of conducting a case study?

The main benefit of conducting a case study lies in the particular details and holistic understanding researchers gain from a specific case. Case studies allow researchers to fully understand how an intervention worked, or why an intervention had an effect in a particular case. In contrast, other forms of research, such as experimental or quasi-experimental research, do not delve into this type of detail, but rather aim to give information on whether or not an intervention has a particular, predefined effect.

All studies attempt to maximize both their internal and external validity. Internal validity addresses how valid it is to make causal inferences about the intervention in the study. External validity addresses how generalizable those inferences are to a larger population. Case studies tend to have very strong internal validity, but are often criticized because of their extremely poor external validity. Because case studies look at only one case at a time, and purposefully choose cases that are atypical, external validity is a real concern.

When should I conduct a case study?

Case studies attempt to examine the *how* and *why* questions associated with an intervention. Case studies either describe or explain what happened in a particular case, by giving a detailed, holistic account of a particular case and allow researchers to see the product used in a natural setting. The general form of a case study research question is “How did the [specific program/intervention] work in a particular case?” Or “Why did the [specific program/intervention] have a particular effect on a particular case?”

Many other forms of research may be more appropriate for your needs, depending on your research question. For example, if one asked “What is the effect of an intervention on a specific population?” or “What is the market demand of x?”, a case study would not be ideal.

1 An experimental design, in contrast, aims to extricate the object of the study from the particulars.

2 Yin, R. (1993). Applications of case study research. Newbury Park, CA: Sage Publishing.

What are the resources needed to conduct a case study?

Even when there are no specific quantitative techniques or validity issues to address when implementing a case study, objectivity is extremely important. It is recommended that organizations use outside consultants or research organizations to conduct case studies. Not only does this allow the case study to be conducted by experts in interviewing, conducting focus groups, and analyzing qualitative data, but it also protects the results of the study from a perceived bias of the organization. For example, while a company with a product that aims at improving literacy in children with learning disabilities might conduct an objective, enlightening case study that shows why their product worked successfully in a specific school, school districts might not trust this result unless it was conducted and analyzed by an unaffiliated organization.

The time and cost of conducting a case study largely depends on the unit of analysis. For example, conducting a case study on a single child's experience using a tele-therapy approach may only take a short period of time and minor costs to gain all relevant information. However, examining how and why an intervention worked within a whole school or within a large district would take much longer and would be far more expensive to gather all relevant interviews, focus groups, and other data. Before initiating a case study, you should be sure that you have the required amount of time and resources to complete it.

Elements of a case study

Study participant recruitment

Recruiting study participants or study sites is critical. First, it is important that the study participants represent the population for which you hope your intervention will be effective. Second, study participants and their parents/guardians (if you are working with minors) must agree to be in the study. This involves getting parent/guardian approval through signing consent forms which describe the study and any risks and benefits that study participants may be exposed to, and then separately asking participants to consent to participate in the intervention. Because case studies examine how or why an intervention worked in a particular case, rather than testing the effects of an intervention, recruiting study participants may be much easier than with other forms of research. Furthermore, since case studies focus on one individual or group, there are fewer people who need to give consent. However, just getting individuals to agree to participate is not enough. Any studies that are funded by government agencies must have the study, data collection items, and even the consent forms approved by an Institutional Review Board (IRB) before study participant recruitment begins.

Case study research often does not keep the research participants' identities anonymous. Cases that are presented with video, still photos, audio tapes, or other artifacts that are personally identifying offer compelling reasons to invite the participants to be active members of the research team. Consent and assent rules still apply, as does oversight by an IRB; however, these participatory cases give voice to the participant and ask participants to help interpret the findings. See more about participatory research.

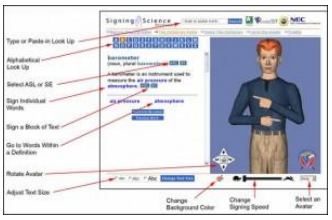
What sorts of data should I collect?

It is critical that researchers conducting case studies collect as much data that may be relevant to the intervention and the context as possible. Typically, researchers will get qualitative data from interviews, focus groups, direct observations, video and audio records, and any extant documents that may pertain to the intervention and context in question. It is best to have developed interview, focus group, and observation protocols beforehand to be sure you capture the data you need to answer your study question.

How should I analyze this data?

Case study data tends to be qualitative in nature, and thus qualitative data analysis methods should be applied. The most common method in qualitative data analysis is "coding." Coding is a process in which researchers analyze data for themes, either pre-determined or emerging. These can be as simple as color coding themes and subthemes with highlighters or with a word processor, or more involved, as assigning abbreviated codes to tag digital content such as audio tapes, video files, documents, etc., within qualitative software packages that can then sort and compile tagged content. Either way, codes will be study specific, depending entirely on the purpose and findings of the study. It is important for multiple researchers to ensure inter-rater reliability (that they are coding with the same assumptions and standards) by comparing and discussing their codes on a percentage of the data. This ensures researchers are thinking about the data in the same way and drawing similar conclusions. Analysis then proceeds from an interpretation of these codes and what they mean for the larger research questions. Read more about coding and other qualitative data analysis methods.

Examples and additional resources



Real world example

Signing Science Dictionary: Benefits to Students and Teachers. For researcher Judy Vesel of TERC and her partners at Vcom3D, developer of the Signing Avatar® assistive technology, NCTI Tech in the Works-funded research demonstrated that a preliminary, 300-word version of the Signing Science Dictionary raised science achievement among students with hearing impairment. The unit of analysis in this study was the classroom where the dictionary was implemented, which allowed the researchers to observe and analyze the behavior and learning of students, teachers, and involved parents.

Final report of the study: http://www.nationaltechcenter.org/documents/NCTI_Report.doc

Published articles using case study

Zorfass, J. & Rivero, K. (2005). Collaboration is key: How a community of practice promotes technology integration. *Journal of Special Education Technology, 20*(3), 51-67.

The authors explain how STAR Tech, a professional development program, used communities of practice to help teachers work together to integrate technology tools into the curriculum to benefit students with and without disabilities. Components of the STAR Tech system include providing teachers with assistance from experts and building leadership capacity to support professional development. Findings from the study demonstrate that a community of practice can promote technology integration. This article will be of particular value to administrators interested in creating a community of practice within their school. However, what makes this article unique is that it presents a professional development program that considers the needs of teachers that service both general and special education students.

Grimes, D. & Warschauer, M. (2010). Utility in a fallible tool: A multi-site case study of automated writing evaluation. *Journal of Teaching, Learning, and Assessment, 8*(6).

Automated writing evaluation (AWE) software uses artificial intelligence (AI) to score student essays and support revision. We studied how an AWE program called MY Access!® was used in eight middle schools in Southern California over a three-year period.

Although many teachers and students considered automated scoring unreliable, and teachers' use of AWE was limited by the desire to use conventional writing methods, use of the software still brought important benefits. Observations, interviews, and a survey indicated that using AWE simplified classroom management and increased students' motivation to write and revise.

Single Subject

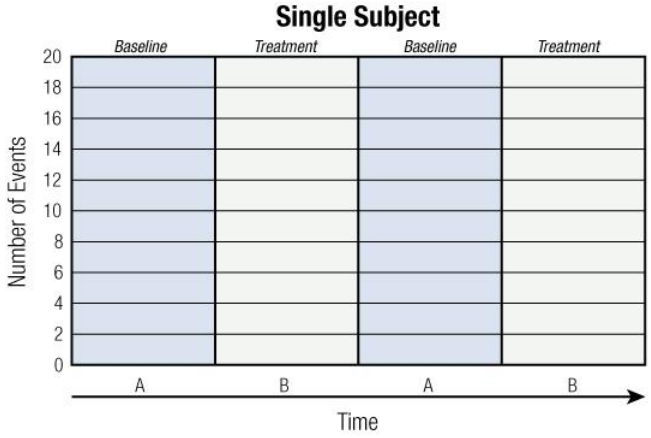
Single subject research is a study which aims to examine whether an intervention has the intended effect on an individual, or on many individuals viewed as one group. The two most common single subject research designs are the *A-B-A-B design*, and *multiple baseline design*. Each of these designs has two main components: (1) a focus on the individual and (2) a design in which each individual is used as his or her own control observation. The focus on the individual differs from other research designs, such as experimental and quasi-experimental designs, which look at the average effect of an intervention within or between groups of people. In single subject research, researchers often use more than one individual, but results are examined by using each individual as his or her own control, rather than averaging results of different groups. Comparisons are made on the behavior of one individual to that same individual at a different point in time.

Single subject research has an important role to play in identifying and documenting solutions for individuals with disabilities. The field needs much more evidence on what works for whom, under what conditions, for which tasks, etc. Although individuals with disabilities—even those with the same diagnosis—often experience unique needs, solutions may be adaptable in different environments, and knowledge sharing can inform others working on assistive solutions.

A-B-A-B design

The A-B-A-B design is a time series design, where A is a baseline observation and B is an observation using the intervention. A baseline observation in single subject research is defined as an observation where the intervention is not present—a "business as usual" time period. Because this research design has a baseline observation after a treatment observation, this type of research design is not applicable to programs or interventions where a subject is taught a skill, since that would require unlearning the intervention. The A-B-A-B design is meant to test the effectiveness of specific methods, tools, or technologies. Furthermore, the outcome the researcher is trying to impact, the dependent variable, must be quantifiable. By having the outcome measure quantifiable, researchers are able to graph and analyze the data experimentally.

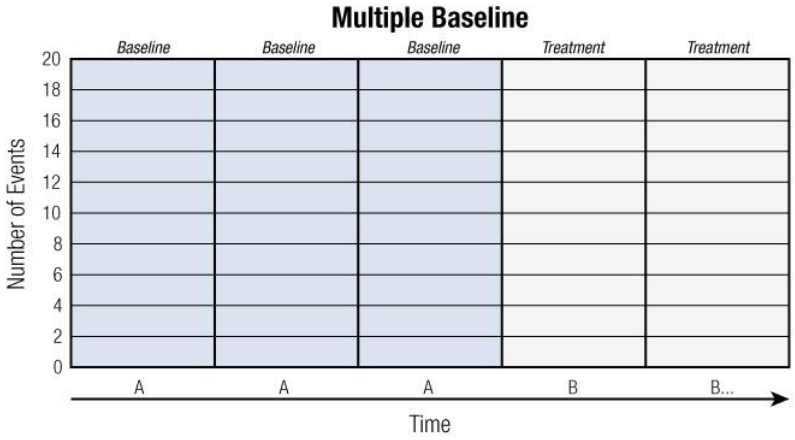
A communication device is an example of a tool that can be tested in the A-B-A-B design. A subject without the device could attempt to communicate to a researcher or caregiver, which would be the first observation, A. Then this same individual could attempt to use the device for communication, B. This same process repeated again would give two baseline and two treatment observations. Of course, the individual and the caregiver would need to be trained to use the device or software, but the absence of it when trying to achieve the same task constitutes the business as usual condition.



Multiple baseline design

Because single subject designs focus on studying individuals rather than groups, they can be particularly vulnerable to threats to internal validity. Internal validity addresses how valid it is to make causal inferences about the intervention in the study. For more information, see section on validity.

Particular internal validity threats in the A-B-A-B single subject research design are maturation (the natural growth in the study participant's ability over time) and test-retest (a study participant doing better on each administration of a test due to their experience taking the test). The multiple baseline design helps to control for these threats to internal validity by having a study participant give multiple baseline observations before using the intervention. Further, if multiple individuals are tested with the treatment given at different time points for different individuals, researchers can have a better understanding of whether or not the treatment is effective. Unlike A-B-A-B single subject research designs, multiple baseline single subject research studies can be used to study programs or interventions where a subject is taught a skill.



What are the benefits of conducting single subject research?

Because single subject research uses each participant as his/her own control subject, researchers can get a better understanding of individual differences rather than the difference of the average between groups. For this reason, single subject research is often considered the best research design when measuring behavioral change. When done correctly and carefully, single subject research can show a causal effect between the intervention and the outcome.

The flexibility, simplicity, and low cost of this study design are also beneficial. While it is important to carefully plan any analyses, the design of single subject research is far more flexible, as you may change the order of the delivery of baseline or treatment observations depending on the individual participant responses. Single subject research can also be much easier to plan, since it can be much smaller in scale than forms of experimental and quasi-experimental research. Because of this, it may also be much cheaper than other research designs.

All studies attempt to maximize both internal and external validity. Internal validity addresses how valid it is make causal inferences about the intervention in the study. External validity addresses how generalizable those inferences are to the general population. Single subject research may produce results that have strong internal validity, when all internal validity threats are addressed. However, due to the small number of study participants, single subject research tends to have poor external

validity, limiting the ability to generalize the findings to a wider audience. For more information, see section on validity.

When should I conduct single subject research?

Single subject research studies attempt to examine the effects of an intervention on an individual. The general form of a research question that a single subject study can answer is "What is the effect of [specific program/intervention] on [specific individuals]?" Many other forms of research may be more appropriate for your needs, depending on your research question. For example, if one asked "How useful is x?" or "What is the market demand of y?", single subject research would not be helpful.

The main limitations of conducting single subject research are issues concerning validity. While the A-B-A-B study design does have some issues with internal validity (mentioned above), the main limitation of single subject research is external validity. The limitation of not being able to generalize from single subject research is a challenge to AT developers. Individuals with disabilities often present unique challenges that are met with unique solutions. Testing the efficacy of these solutions is important, but they may not be applicable to other individuals. Nevertheless, rich description of the need and the solution, in addition to the analyses of the intervention, may be helpful to others in the field.

What are the resources needed to conduct single subject research?

While conducting single subject research is much easier than conducting quasi-experimental or experimental research, it can still be difficult to implement. It is necessary to understand all of the possible threats to the study's validity, as well as the statistical methods needed to run accurate analyses. It is recommended that organizations use outside consultants or research organizations to run single subject research. Not only does this allow the single subject research to be conducted by experts in study design, implementation, and analysis, but it also protects the results of the study from a perceived bias of the organization. For example, while a company with a product that is for children with learning disabilities might conduct a valid and bias-free study that shows that their product does in fact improve literacy in children with learning disabilities, school districts might not trust this result unless it was conducted and analyzed by an unaffiliated organization.

Single subject research tends to take less time and money to conduct than other forms of experimental research. This is largely due to (1) the nature of the intervention, testing specific methods, tools, or technologies, rather than programs or interventions, and (2) the small number of study participants.

Elements of single subject research

Study participant recruitment

First, it is important that study participants are members of the population in which you hope your intervention will be effective. Second, study participants must agree to be in the study. Often, this involves getting parent/guardian approval by signing consent forms which describe the study and any risks and benefits that study participants may be exposed to. Due to the small number of study participants needed to perform single subject research, this process is far easier than with other forms of research. However, just getting individuals to agree to participate is not enough. Any studies that are funded by government agencies must have the study, data collection items, and even the consent forms approved by an Institutional Review Board before study participant recruitment begins. See more about Institutional Review Boards (IRB).

What sorts of data should I collect?

In order to analyze data in single subject research, it is important that the data you collect—usually measures of a behavior—be quantitative in nature. Some examples of quantitative data include test scores and observations (how many times each person did x).

How should I analyze this data?

The main form of analysis in single subject research is graphic analysis. In graphic analysis, you graph the data to see how it changes over time in both baseline and treatment conditions. For examples of graph templates, see A-B-A-B design, and Multiple baseline design.

For more resources on graphic analysis and single subject design see:

Wikipedia: Single-subject Research

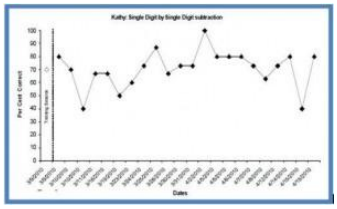
Center for the Study of Ethics in the Professions: Single Subject Research Design

Examples and additional resources

Real world example

Instant Messaging for AAC Users: Cool Heads and Collegiality Promote Assistive Technology Innovation. This NCTI 2008 Tech in the Works research award found unexpected discoveries when researchers turned an AAC platform into an instant messaging device, such as the critical need for chat specific vocabularies. The researcher and developer worked with individual AAC users in a single subject design that informed further technology development.

Final report of the study:
http://www.nationaltechcenter.org/documents/point_and_chat_final_report.pdf.



Scaffolding Early Math Concepts with Stages Math: Number Sense. This 2009 NCTI Tech in the Works research award studied how regular classrooms could meet the needs of diverse young learners by using Stages Math. The study utilized a single subject design and principles of universal design for learning.

http://www.nationaltechcenter.org/index.php/2011/04/05/case-early-math-concepts/

Published articles using single subject research

Autism Spectrum Disorders & Augmentative and Alternative Communication. (January 2010). *reSearch: A collection of research reviews on rehabilitation topics from NARIC and other information resources,5*(1).

The entire collection focuses on Autism Spectrum Disorders & Augmentative and Alternative Communication research, a field that relies on single subject design to personalize and customize devices for individual needs.

Quasi-Experimental Study

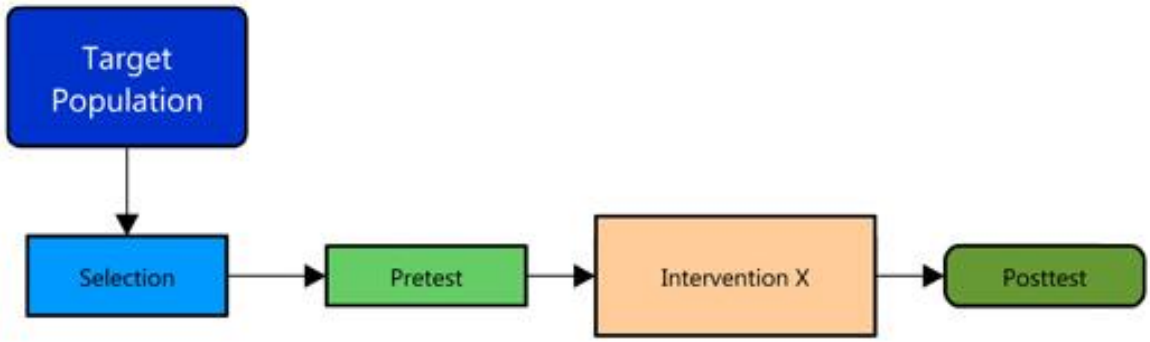
A quasi-experimental study is a type of evaluation which aims to determine whether a program or intervention has the intended effect on a study's participants. Quasi-experimental studies take on many forms, but may best be defined as lacking key components of a true experiment. While a true experiment includes (1) *pre-post test design*, (2) *a treatment group* and *a control group*, and (3) *random assignment* of study participants, quasi-experimental studies lack one or more of these design elements.

Since the most common form of a quasi-experimental study includes a pre-post test design with both a treatment group and a control group, quasi-experimental studies are often an impact evaluation that assigns members to the treatment group and control group by a method other than random assignment. Because of the danger that the treatment and control group may differ at the outset, researchers conducting quasi-experimental studies attempt to address this in a number of other ways (e.g., by matching treatment groups to like control groups or by controlling for these differences in analyses). This section focuses on two forms of quasi-experimental studies: a pre-post test design study without a control group and a pre-post test design with a control group.

Pre-post test design study without a control group

A pre-post test design requires that you collect data on study participants' level of performance before the intervention took place (pre-), and that you collect the same data after the intervention took place (post-). This study design only looks at one group of individuals who receive the intervention, which is called the treatment group. The pre-post test design allows you to make inferences on the effect of your intervention by looking at the difference in the pre-test and post-test results. However, interpreting the pre-test and post-test difference should be done with caution since you cannot be sure that the differences in the pre-test and the post-test are causally related to the intervention.

Study design

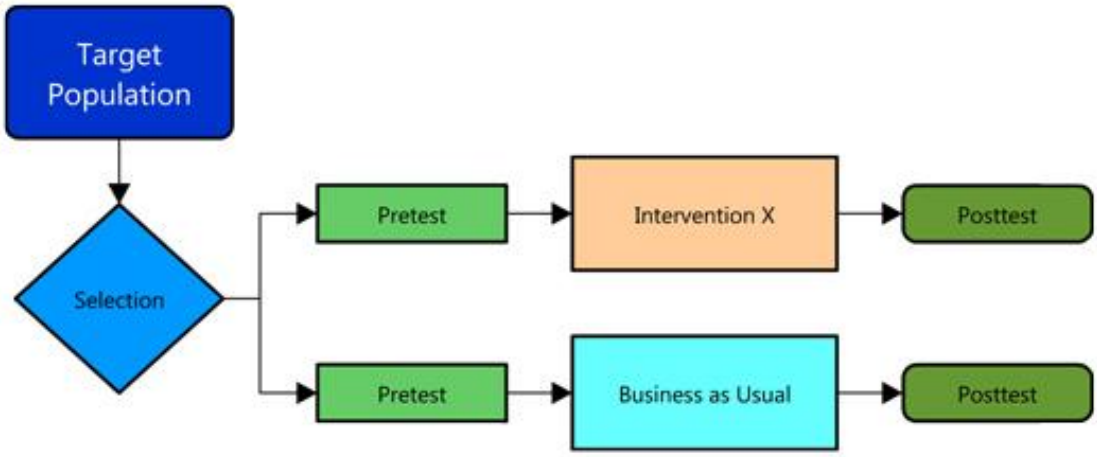


Pre-post test design with a control group

While the pre-post test design will allow you to measure the potential effects of an intervention by examining the difference in the pre-test and post-test results, it does not allow you to test whether this difference would have occurred in the absence of your intervention. For example, perhaps the effect of improved academic achievement is due to the students getting used to taking a test rather than the use of educational software. To get the true effects of the program or intervention, it is necessary to have both a treatment group and a control group. As the names suggest, the treatment group receives the intervention. The control group, however, gets the business-as-usual conditions,

meaning they only receive interventions that they would have gotten if they had not participated in the study. By having both a group that received the intervention and another group that did not, researchers control for the possibility that other factors not related to the intervention (e.g., students getting accustomed to a test, or simple maturation over the intervening time) are responsible for the difference between the pre-test and post-test results. It is also important that both the treatment group and the control group are of adequate size to be able to determine whether an effect took place or not. While the size of the sample ought to be determined by specific scientific methods, a general rule of thumb is that each group ought to have at least 30 participants.

Study design



What are the benefits of conducting a quasi-experimental study?

As mentioned above, the main difference between a quasi-experimental study and a true experimental study is that in an experimental study, the participants are assigned to a treatment group or a control group by random assignment. While doing so will allow you to get the best evidence of whether or not your intervention had the intended causal effect, random assignment is not always a practical step to take in the real world. For example, an organization may want to test the effects of an intervention on 4th grade special education students' literacy. It is usually impractical to ask a school or school system to divide up students in their school into two separate classes through random assignment. Furthermore, it is unreasonable to ask a school to do this midyear. When random assignment is impractical, following a pre-post test design with a control group is the best route to go.

Often it may not be practical to divide up study participants into both a treatment and control group at all. For example, if an organization approached a small elementary school to test the effects of an intervention on 4th grade special education students' literacy, this school may only have one fourth-grade class. Dividing up the students into two groups may be impractical in the classroom setting. The pre-post test design, in this case, may be give you the best results with minimal classroom disruptions.

Ethical considerations

In many cases, withholding the intervention from the control group is ethical, since being in the study leaves them just as well off as they would have been had they not participated in the study. However, for vulnerable populations (e.g., students with disabilities) this may not be as straightforward. If researchers have good reason to believe that an intervention will benefit their study participants, denying this intervention to a control group may raise ethical questions.

Conducting a pre-post test study addresses this ethical concern by offering the intervention to all study participants. For more information, see section on ethical considerations.

When should I conduct a quasi-experimental study?

Quasi-experimental studies attempt to examine the effects of an intervention on a specific population. While you will not be able to make definitive causal inferences about the effects of the intervention through a quasi-experimental study, the general form of a research question that a quasi-experimental study can answer is "What is the effect of [specific program/intervention] on [a specific population]?"

Many other forms of research may be more appropriate for your needs, depending on your research question. For example, if one asked "How useful is x?" or "What is the market demand of y?", quasi-experimental research would not be helpful.

What are the resources needed to conduct a quasi-experimental study?

Quasi-experimental studies present their own set of challenges. Understanding all of the possible threats to the study's validity, as well as the statistical methods needed to run accurate analyses is necessary. It is recommended that organizations use outside consultants or research organizations to run quasi-experimental studies. Not only does this allow the quasi-experimental study to be conducted by experts in study design, implementation, and analysis, but it also protects the results of the study from a perceived bias of the organization. For example, a company with a product that aims at improving literacy in children with learning disabilities might conduct a valid and bias-free study that shows that their product does, in fact, improve the literacy in children with learning disabilities. The reality is that school districts might not trust this result unless the study was conducted and analyzed by an unaffiliated organization. If you are working with an affiliated researcher, be sure to disclose the relationship up front so that consumers of the reports can judge any potential conflict of interest.

Because of the intricacies of quasi-experimental studies—the design process, pre- and post-test development, and analysis—they tend to take approximately six months to a year. For similar reasons, quasi-experimental studies tend to be more expensive than other forms of research. Before initiating a quasi-experimental study, you should be sure that you have the required amount of time and resources to complete it.

Other than the time and cost limitations of quasi-experimental studies, they often do a poor job controlling for the internal validity of the study. In studies with poor internal validity, researchers often will have to qualify their findings by leaving open the suggestion that the intervention was not the only factor in students' success or lack thereof. For example, a finding might read "while we can't be sure that this intervention improved results for reasons a, b, and c, the evidence shows that the intervention had positive effects on students' performance such as….."

Elements of a quasi-experimental study

Study participant recruitment

First, it is important that the study participants are members of the population in which you hope your intervention will be effective. Second, study participants must agree to be in the study. Often, this involves getting parent/guardian approval by signing consent forms which describe the study and any risks and benefits that study participants may be exposed to. However, just getting individuals to agree to participate is not enough. Any studies that are funded by government agencies must have the study, data collection items, and consent forms approved by an Institutional Review Board

before study participant recruitment begins. For more information, see section on Institutional Review Boards (IRB).

What sorts of data should I collect?

For quasi-experimental studies, it is important to collect multiple forms of data. Ideally, a researcher will collect descriptive information, data on the fidelity of the study, data on the dosage of the intervention, and outcome data.

Descriptive, or contextual, information will allow the researchers to understand the context and the details of the environment in which the study takes place. This may be background information on the participants in your study, or information about prior interventions they have received.

Data on the fidelity of the study is information that may allow researchers to confirm that the study was conducted as planned. This may be confirmation that your treatment group—those people who received the intervention—did in fact get the full treatment as planned.

Data on the dosage of the intervention measures the quantity of the intervention. Dosage data is important to collect, not only because it may confirm your fidelity data, but because this data is also collected on the control group—those participants in the study who did not receive the treatment. While your study will not offer treatment to the control group by design, it is important to know that the control group members did not seek alternate treatment or interventions outside of the study.

Finally, it is essential in a quasi-experimental study that you collect outcome data. In order to be able to analyze your outcome data, it is important that this data is quantitative in nature. Some examples of quantitative data include test scores, observations (how many times each person did x), tracking/log data on how users interacted with a device or software, and survey responses (asking people to rate answers on a scale—e.g., strongly agree, agree, disagree, strongly disagree).

Because you cannot make definitive causal inferences from quasi-experimental quantitative data alone (e.g., “this device improves communication skills”), it is also important that your outcome data is supplemented with additional forms of qualitative data. Qualitative data, in the form of study participant interviews and focus groups, can give valuable information that may explain the quantitative results. For example, study participants may speak to why the intervention worked for them, or may clue researchers in to other factors outside of the study, that influenced their post-test results.

How should I analyze this data?

What data analysis you do depends on the research question. However, by and large, researchers will examine the descriptive information to explain the context of the study, analyze the fidelity and dosage implementation to determine if the study happened as planned, and then use statistical methods to analyze the outcome data. Statistical methods vary depending on the specific quasi-experimental design. Quasi-experimental studies rely primarily on simple statistical tests, like t tests. Typically, quasi-experimental studies with a control group use statistical equations called regressions. Statistical regressions are data equations that allow one to see the numerical effect of the treatment status by controlling for participant characteristics and pretest scores. For more information on statistical tests, see these resources:

Engineering Statistics Handbook: What Are Statistical Tests?

Intuitive Biostatistics: Choosing a Statistical Test

UCLA Academic Technology Services: Choosing the Correct Statistical Test

For each type of quasi-experimental study design, qualitative data analysis methods should be applied. The most common method in qualitative data analysis is "coding." Coding is a process in which researchers read through the qualitative data and enter in agreed-upon short codes, which help enumerate and draw attention to themes. Codes will be unique to the study, depending entirely on the purpose of the study. It is important for multiple researchers to code the same data, to ensure inter-rater reliability. For example, in the study described below, Fraction Sense, the teacher's instructional language was audio and video recorded. These tapes were then watched and key phrases or instructional moves were noted on a coding sheet for how often and to what degree teachers used the instructional language which they were taught during the professional development training. This allowed the researchers to determine whether the instruction was being given with fidelity and also cross-check whether students who received better instruction made more gains with the software.

See more resources on quasi-experimental studies:

Web Center for Social Research Methods: Quasi-Experimental Design

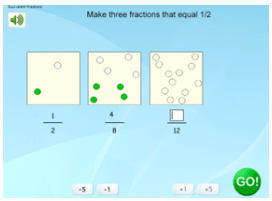
Web Center for Social Research Methods: Other Quasi-Experimental Designs

Colorado State University: Differences Between Experimental and Quasi-Experimental Research

For more information on coding, and other qualitative data analysis methods, see the section on case study design.

Examples and additional resources

Real world example



Fraction Sense Software Assists Math Students**.** This 2008 NCTI Tech in the Works award shows how collaborative research can overcome implementation challenges in public schools and technology can be developed to support all students. Using a multiple classrooms and a pre-post test design, this study shows how quasi-experimental research can be conducted in school environments.

Final report of the study:
http://www.nationaltechcenter.org/documents/FractionSenseFinalReport.pdf

Published articles using a quasi-experimental study

Shapley, K. S., Sheehan, D., Maloney, C. & Caranikas-Walker, F. (2010). Evaluating the implementation fidelity of technology immersion and its relationship with student achievement. *Journal of Teaching, Learning, and Assessment, 19*(4).

This study shows how researchers can document fidelity and the difference high quality implementation can make for a program or initiative.

Experimental Study

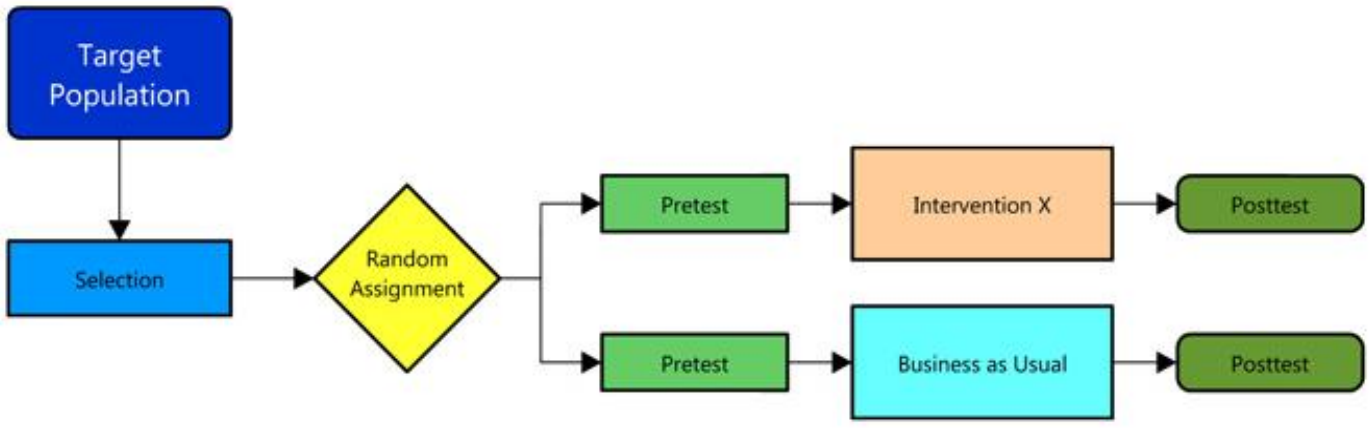
An experimental study is a type of evaluation that seeks to determine whether a program or intervention had the intended causal effect on program participants. There are three key components of an experimental study design: (1) *pre-post test design*, (2) a *treatment group* and a *control group*, and (3) *random assignment* of study participants.

A pre-post test design requires that you collect data on study participants' level of performance before the intervention took place (pre-), and that you collect the same data on where study participants are after the intervention took place (post). This design is the best way to be sure that your intervention had a causal effect.

To get the true effects of the program or intervention, it is necessary to have both a treatment group and a control group. As the name suggests, the treatment group receives the intervention. The control group, however, gets the business-as-usual conditions, meaning they only receive interventions that they would have gotten if they had not participated in the study. By having both a group that received the intervention and another group that did not, researchers control for the possibility that other factors not related to the intervention (e.g., students getting accustomed to a test, or simple maturation over the intervening time) are responsible for the difference between the pre-test and post-test results. It is also important that both the treatment group and the control group are of adequate size to be able to determine whether an effect took place or not. While the size of the sample ought to be determined by specific scientific methods, a general rule of thumb is that each group ought to have at least 30 participants.

Finally, it is important to make sure that both the treatment group and the control group are statistically similar. While no two groups will ever be exactly alike, the best way to be sure that they are as close as possible is having a random assignment of the study participants into the treatment group and control group. By randomly assigning participants, you can be sure that any difference between the treatment group and control group is due to chance alone, and not by a selection bias.

Study design



What are the benefits of conducting an experimental study?

An experimental study is often considered the gold standard of research. Because of the pre-post tests, treatment and control groups, and group random assignment, experimental studies address more threats to internal validity than any other type of study. By having greater internal validity, an

experimental study will have the best chance of determining whether or not a program or intervention had a causal effect on the treatment group. Furthermore, any findings from an experimental study can be applied to the population from which the study's samples were drawn.

For example, a robust study conducted in twelve fourth-grade math classes would probably represent the population of U.S. fourth graders and fourth-grade classrooms well enough for its findings to be considered applicable to all U.S. fourth-grade math classes.

When should I conduct an experimental study?

While experimental studies are considered to have the most internal validity, they are not always the most appropriate. As mentioned above, experimental studies are best used to address whether a program or intervention had the intended causal effect on program participants. Further, it is necessary that the program or intervention can be measured quantitatively in some fashion (through a knowledge test, observations, survey questions, etc.). The general form of a research question that an experimental study can answer is similar to a quasi-experimental study: "What is the effect of [specific program/intervention] on [a specific population]?

Many other forms of research may be more appropriate for your needs, depending on your research question. For example, if one asked "How useful is x?" or "What is the market demand of y?", experimental research would not be helpful.

"The specific questions that the experiment is intended to answer must be clearly identified before carrying out the experiment. We should also attempt to identify known or expected sources of variability in the experimental units since one of the main aims of a designed experiment is to reduce the effect of these sources of variability on the answers to questions of interest. That is, we design the experiment in order to improve the precision of our answers." (Taken from Valerie J. Easton and John H. McColl's *Statistics Glossary v1.1*.)

What are the resources needed to conduct an experimental study?

Experimental studies are often difficult to implement because they can be so complex. Researchers must understand all the possible threats to the study's validity, as well as the statistical methods needed to run accurate analyses. It is recommended that organizations use outside consultants or research organizations to run experimental studies. Not only does this allow the experimental study to be conducted by experts in study design, implementation, and analysis, but it also protects the results of the study from a perceived bias of the organization. For example, a company with a product that aims to improve literacy in children with learning disabilities might conduct a valid and bias-free study that shows that their product does in fact improve the literacy in children with learning disabilities. The reality is that school districts might not trust this result unless the study was conducted and analyzed by an unaffiliated organization. If you are working with an affiliated researcher, be sure to disclose the relationship up front so that consumers of the reports can judge any potential conflict of interest.

Because of the intricacies of experimental studies—the design process, the random assignment, pre- and post-test development, and analysis—they tend to take more time than most other types of studies, lasting for years in some cases. For similar reasons, experimental studies tend to be much more expensive than other forms of research. Given that at least two full groups need to be recruited, these studies usually involve more participants and more settings, too. Before initiating an experimental study, you should be sure that you have the required amount of time and resources to complete it.

See these resources for an experimental study:

Wikipedia: Design of Experiments

Experimental Research

AAAS Office of Research Integrity Bibliography

Ethical considerations

Some ethical considerations apply specifically to conducting experimental research. The design of an experimental study dictates that there is both a treatment group, which receives the intervention, and a control group, which does not. In many cases denying the control group the intervention is ethical, since no harm is done to them, and they are as well off as they would have been had they not participated in the study. However, for vulnerable populations (e.g., students with disabilities), this is not as straightforward. If researchers have good reason to believe that an intervention will benefit their study participants, denying this intervention to a control group can be considered unethical. When you have an intervention meant to benefit vulnerable populations, you may consider another form of research design, such as a quasi-experimental research design.

Elements of an experimental study

Study participant recruitment

Recruiting study participants can be difficult. First, it is important that the study participants are members of the population in which you hope your intervention will be effective. Second, study participants must agree to be in the study. Often, this involves getting parent/guardian approval by signing consent forms which describe the study and any risks and benefits that study participants may be exposed to. But just getting individuals to agree to participate is not enough. Any studies that are even partially funded by government agencies must have the study, data collection items, and even the consent forms approved by an Institutional Review Board before study participant recruitment begins. For more information, see section on Institutional Review Boards (IRB).

What sorts of data should I collect?

For experimental studies, it is important to collect multiple forms of data. Ideally, a researcher will collect descriptive information, data on the fidelity of the study, data on the dosage of the intervention, and outcome data.

Descriptive, or contextual, information will allow the researchers to understand the context and the details of the environment in which the study takes place. This may be background information on the participants in your study, or information about prior interventions they have received.

Data on the fidelity of the study is information that may allow researchers to confirm that the study was conducted as planned. This may be confirmation that your treatment group—those people who received the intervention—actually did in fact get the full treatment.

Data on the dosage of the intervention measures the quantity of the intervention. Dosage data is important to collect, not only because it may confirm your fidelity data, but because this data is also collected on the control group—those people in the study who did not receive your treatment. While your study will not offer treatment to the control group by design, it is important to know that the control group members did not seek alternate treatment or interventions outside of the study.

Finally, it is essential in an experimental study that you collect outcome data. In order to be able to analyze your outcome data, it is important that this data is quantitative in nature. Some examples of quantitative data include test scores, observations (how many times each person did x), tracking/log

data on how users interacted with a device or software, and survey responses (asking people to rate answers on a scale—e.g., strongly agree, agree, disagree, strongly disagree).

How should I analyze this data?

What data analysis you do depends on the research question. However, by and large, researchers will examine the descriptive information to explain the context of the study, analyze the fidelity and dosage implementation to determine if the study happened as planned, and then use statistical methods to analyze the outcome data. Typically, experimental studies use statistical equations called regressions. Statistical regressions are data equations that allow one to see the true numerical effect of the treatment status by controlling for participant characteristics and pretest scores. Other times, simple statistical tests, like t tests, may suffice. For more information on statistical tests, see these resources:

Engineering Statistics Handbook: What Are Statistical Tests?

Intuitive Biostatistics: Choosing a Statistical Test

UCLA Academic Technology Services: Choosing the Correct Statistical Test

Examples and additional resources

Real world example

Teaching Children with Autism Through Technology. This 2008 NCTI Tech in the Works award shows how collaborative research can sustain a challenging study in one of the nation's most diverse school districts, Los Angeles Unified. In this experimental design study, researchers looked at the effects of a Computer-Assisted Instruction (CAI) program on preschoolers and first-graders with autism. The study looked at 50 children with autism (25 in the treatment group, 25 in the control group) and took place over a full school year, involving dozens of teachers and paraprofessionals, as well as the children's parents.

Final report from the study:
http://www.nationaltechcenter.org/documents/TiW_FinalReport_TeachTown.pdf

Published articles using an experimental design

The National Study of the Effectiveness of Educational Technology Interventions

This was a very large study with random assignments of control and treatment groups implementing educational technology, funded by the U.S. Department of Education. Findings were published in two waves, 2007 and 2009.

KEY CONCEPTS

Validity and Reliability

Internal and external validity

All studies attempt to maximize both their internal and external validity.

Internal validity addresses how valid it is to make causal inferences about the intervention in the study. The most common threats to internal validity are selection bias, history, maturation, test-retest, differential attrition, and regression towards the mean. The main elements in study design that address internal validity are the use of a treatment and control group, as well as random assignment. By randomly assigning participants, you can be sure that any difference between the treatment group and control group is due to chance alone, and not selection bias.

External validity addresses how generalizable the study's inferences are to the general population. A study's external validity is both dependent on, and at odds with, internal validity. A study that has little to no internal validity cannot claim a causal effect of an intervention, and thus, cannot be generalized. However, in order to strengthen internal validity, studies tend to focus on specific populations (for example, the effects of an intervention on seventh-grade reading scores among learning disabled students in New York City). While limiting the scope of a study allows for greater control over the characteristics of the treatment and control group, as well as some control over history and maturation, the results are less likely to be generalizable. What works for public school students New York City may not work for students in rural Alabama or for private school students in Los Angeles because the populations may be meaningfully different.

Measurement validity and reliability

Case studies, single subject, quasi-experimental and experimental research all involve using one or more instruments to measure outcomes. The measurement validity and reliability of your testing instruments is a critical factor to consider when designing your study.

Measurement validity addresses how accurately the instrument measures the outcome or construct your intervention is attempting to affect. In this context, an instrument is valid if it actually measures what you intend it to measure. Items such as commercial rulers or scales are straightforward examples of instruments with strong measurement validity. However, the validity of a tool that attempts to measure growth in cognitive ability or increased behavior tendencies (such as increases in mobility) is not as clear.

Measurement reliability addresses the consistency of your instrument's measurement. That is, would your testing instrument generate the same result in similar circumstances? Again, think of a typical measuring instrument, such as a ruler. Using a ruler—the same ruler—to measure something over and over again will give you a very reliable value. Yet standardized tests, such as the SAT or GRE, may generate very different results from the same individual at different points in time or under different conditions (e.g., paper and pencil vs. computer).

Note that an instrument can be valid, but not reliable; or reliable, but not valid. Using our examples above, the SAT may be a valid indicator of cognitive ability, though it may not do so reliably. Alternatively, almost any ruler is a reliable tool for measurement – though a warped ruler would not be valid.

Tips for boosting measurement validity and reliability:

General:

- Always consider pilot testing your instrument with the target population of your research.
- Have experts in the area of your research check or provide guidance on your data collection tools.

Skilled-based tests:

- It is imperative that the test you select will collect data on the types of skills your research is targeting. For example, if you are teaching math to children with cognitive impairments, you will need a test that will be sensitive enough to detect growth in their learning within your timeframe. This is a question best determined in consultation with a professional researcher in your area of study.

Surveys, interviews and focus groups:

- You need to check your questions to determine if they are prompting the types of responses you expect. Run a pilot test with a small set of people from your target population. Note that these must be people who will not otherwise be involved in the study.

Observations:

- The observation protocol or record keeping sheet is critical to getting credible data. Spend time to pilot the protocol with your observers. Try it out in a shared observation (a video-taped classroom would be effective for this) and then discuss ratings. Did all the raters mark events in the same manner? If not, why not? It is critical to work this out in advance.

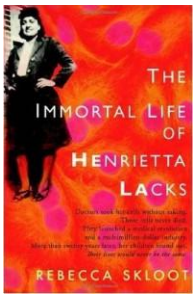
For more information, see: http://www.socialresearchmethods.net/kb/relandval.php.

Ethics

Ethical considerations are important at all stages of research. Any research that involves human subjects is guided by the ethical principles detailed in the Belmont Report (1974). The Belmont Report describes the three basic principles in research involving human subjects: respect for persons, beneficence, and justice. The principle of respect for persons contains two important elements. First, that we must treat all persons as autonomous beings; and second, that we are required to protect persons with diminished autonomy. Beneficence requires that researchers weigh the cost-benefit to research participants. Beneficence mandates that researchers first do not harm study participants, and second, maximize benefits. Finally, the principle of justice in research requires that the benefits of research are fairly distributed, i.e., that groups of people that may benefit from the research are not denied it, and that research is not conducted on groups of people who may not benefit from it. For more information for these principles and their applications, see the full text of the Belmont Report.

Other ethical considerations apply to conducting all forms of experimental research. The design of an experimental study dictates that there is both a treatment group that receives the intervention, and a control group that does not. In many cases denying the control group the intervention is ethical, since no harm is done to them, and they are as well off as they would have been had they not participated in the study. However, for vulnerable populations, e.g., students with disabilities, this is not as straightforward. If researchers have good reason to believe that an intervention will benefit their study participants, denying this intervention to a control group can be considered unethical. When you have an intervention meant to benefit vulnerable populations, you may consider another form of research design—such as a quasi-experimental research design.

See full coverage of ethics in "What is Ethics in Research and Why Is It Important?"



For a human interest story that captures the history and impetus behind institutional review of science, read *The Immortal Life of Henrietta Lacks* by Rebecca Skloot (2010), Crown Publishers.

Institutional Review Board (IRB)

Research projects are monitored by an institutional review board (IRB) in order to protect the rights and welfare of human subjects. This process involves submitting proper paperwork to the IRB, including your study design, protocols, consent forms, and other documents. Studies that involve vulnerable populations, such as minors, people with cognitive impairments, and prisoners, generally require additional paperwork and consideration. Research universities usually have institutional review boards. More than likely, you can utilize their services if you are working with a researcher affiliated with a university. Establishing an IRB for your own company may be possible, but will require the recruitment of qualified researchers and ethicists to contribute time to the review process. Following is a list of links to IRB information for various federal agencies and universities:

Department of Education

Office for Human Research Protections (OHRP) Database

Health and Human Services

National Institutes of Health

National Science Foundation

University of Michigan

University of Virginia

RESOURCES

List of Rehabilitation Engineering Research Centers

A network of research and development centers, funded by the U.S. Department of Education, National Institute on Disability and Rehabilitation Research (NIDRR), provides a window in the cutting edge of technology innovation in assistive technology. These centers conduct basic and applied research on many aspects of disability. They are a great place to find researchers and graduate students with expertise in your area of interest as well as links to ongoing projects, presentations of findings, and publications.

Accessible Public Transportation (RERC APT)

Researches and develops methods to empower consumers and service providers in the design and evaluation of accessible transportation equipment, information services, and physical environments.

Visit Website

Contact:
Aaron Steinfeld, Principal Investigator
P: 412-268-6346
E: steinfeld@cmu.edu

Advancement of Cognitive Technologies (RERC-ACT)

Conducts research and development on assistive technologies for people with cognitive disabilities.

Visit Website

Contact:
Cathy Bodine, Principal Investigator
P: 1-800-255-3477
E: rerc.act@ucdenver.edu

Communication Enhancement (AAC-RERC)

Conducts a comprehensive program of research, development, training, and dissemination activities that seek to improve technologies for individuals who rely on augmentative and alternative communication (AAC) technologies.

Visit Website

Contact:
Frank DeRuyter, Co-Principal Investigator
P: 919-684-6271
E: aac-rerc@mc.duke.edu

Hearing Enhancement (RERC-HE)

Builds and tests components of an innovative model of aural rehabilitation (AR) tools, services, and training in order to assure a better match between hearing technologies and individuals in their natural environments.

Visit Website

Contact:
Matthew H. Bakke, Principal Investigator
P: 202-651-5335
E: RERC-HE@gallaudet.edu

Knowledge Translation for Technology Transfer (KT4TT)

Studies and applies the theory and practice of knowledge translation (KT) to the knowledge outputs of NIDRR technology grantees.

Visit Website

Contact:
Joseph Lane, Principal Investigator
P: 716-829-3266
E: joelane@buffalo.edu

Recreational Technologies and Exercise Physiology Benefiting Persons with Disabilities (RERC RecTech)

Identifies existing and needed recreational and fitness technologies for people with disabilities; and determines feasibility, efficacy, and safety of various recreational and exercise technologies in improving health and function for people with disabilities.

Visit Website

Contact:
James H. Rimmer, Principal Investigator
P: 312-413-9651
E: jrimmer@uic.edu

Robotics and Telemanipulation Machines Assisting Recovery from Stroke Rehabilitation (MARS-RERC)

Evaluates the utility of simple robotic devices for providing rehabilitation therapy after hemispheric stroke.

Visit Website

Contact:
Jim Patton, Co-Principal Investigator
P: 312/238-1277
E: j-patton@northwestern.edu

Smith-Kettlewell Eye Research Institute (S-K RERC)

Develops new technology and methods for understanding, assessment and rehabilitation of blindness and visual impairment.

Visit Website

Contact:
Deborah Gilden, Associate Director
P: 415-345-2110, ex. 2114
E: RERC@ski.org

Successful Aging with Disability: Optimizing Participation Through Technology (OPTT-RERC)

Develops and delivers cutting-edge technologies for identification, evaluation, and rehabilitation of motor processes that facilitate or impede functional performance, employment, and community participation for individuals aging with and into disability.

Visit Website

Contact:
Carolee J. Winstein, Co-Principal Investigator
P: 323-442-2903
E: agingrerc@usc.edu

Wheelchair Transportation Safety (RERC WTS)

Conducts research that advances the safety, usability, and independence of people who remain seated in their wheelchairs when traveling in motor vehicles.

Visit Website

Contact:
Lawrence W. Scheneider, Co-Principal Investigator
P: 734-936-1103
E: lws@umich.edu

Wireless Technologies (WIRELESS RERC)

Promotes equitable access to and use of wireless technologies by persons with disabilities; and encourages adoption of Universal Design in future generations of wireless technologies.

Visit Website

Contact:
Michael Jones, Co-Director or Helena Mitchell, Co-Director
P: 404-367-1348
E: rerc@wirelessrerc.org

Workplace Accommodations (Work RECR)

Identifies, develops and promotes new assistive and universally designed technologies that maximize independence and participation of people with disabilities in the workplace.

Visit Website

Contact:
Karen Milchus, Principal Investigator
P: 800-726-9119
E: workrerc@coa.gatech.edu

Funding Resources

Identifying funding for a research initiative can be challenging. While funding is generally allocated for research prior to the development phase, it is often overlooked when trying to understand the impact that a product has on its intended audience. Fortunately, there are government entities and foundations that can support such research efforts. The federal government has one website consisting of a database with information on all available federally grants. Therefore, if you were interested in applying for a grant under the Department of Education, the National Science Foundation, or the National Institutes of Health, you would search in one single database. See description of Grants.gov below.

Grants.gov

Grants.gov is your source to find and apply for federal government grants. The U.S. Department of Health and Human Services is proud to be the managing partner for Grants.gov, an initiative that is having an unparalleled impact on the grant community. Learn more about Grants.gov and determine if you are eligible for opportunities offered on this site.

eSchoolNews

eSchoolNews is an online resource that provides technology news to educators online. The website has an entire section dedicated to funding, providing information on funding news, deadline grants, ongoing grants, and more. Registration for this resource is free.

National Center for Technology Innovation

NCTI maintains a website of links to funding agencies and streams at http://www.nationaltechcenter.org/index.php/category/funding/. The Center sends bi-weekly email blasts that include funding alerts; sign up at http://www.nationaltechcenter.org/wp-login.php?action=register.

Foundation Center

The Foundation Center, as a nonprofit service organization designed to connect nonprofits and their grantmakers, maintains a Foundation Finder database as well as a Foundation Directory online. Their website enables users to find information about a particular grantmaker such as address and fiscal information, or look for local resources and check statistics. The Foundation Directory Online provides accurate and weekly updated information on funders and grants; subscribe here https://fcsecure.fdncenter.org/fdo_signup_prof/register.php?setplan=start.

Technology Grant News

Technology Grant News is published four times a year and includes in their publication the latest information about grants offered and funding available for technology. This online subscription service houses a Grant Index organized by sector of interest.

Federal Business Opportunities

Search more than 32,000 active federal opportunities for both the buyers and public.

How to Work with a Professional Librarian

Consulting a professional librarian or an information specialist can jumpstart your literature search. These professionals will help you be more efficient by honing your search terms, eliminating redundancies and dead ends, and identifying the most relevant sources of information. If you have any type of university or medical affiliation, you may have access to professional librarian services for free. Many states offer these services for free to any resident citizen. Information specialists are a growing profession of consultants; you may find a referral to them from a local public librarian.

Request a consultation and be prepared to share what you are looking for (e.g., peer reviewed articles, practitioner or popular articles), a time range (e.g., are studies older than 1999 really going to reflect the features you are studying?), and key terms that will help focus the search (e.g., AAC, augmentative communication, communication, language development, etc.). If you know researchers who have published on the topic you are interested in, let the librarian know so he or she can look up their articles to work backwards and see which keywords are used to define these types of studies.

Annotated list of research journal databases

Before engaging in any research initiative, it is important to identify other studies within the field that are related to your project. This will help you determine gaps in the research base, shape your study design, and refine your research questions. Online databases offer a convenient alternative to library research; however, most require a subscription fee. Students and faculty members have access to many of the most commonly used databases and some states allow resident citizens access through the library portal. You will also find that some literature is available online, and can be identified through a simple Google Scholar search. Following are some of the most frequently used research journal databases.

- **EBSCO** has served the library industry for more than 60 years. EBSCO provides customers with an integrated service that combines reference databases, subscription management, online journals, books, linking services and A-to-Z solutions.
- **ERIC**, the Education Resources Information Center, is an online digital library of education research and information. ERIC is sponsored by the Institute of Education Sciences (IES) of the U.S. Department of Education. ERIC provides ready access to education literature to support the use of educational research and information to improve practice in learning, teaching, educational decision-making, and research.
- **Gale**, part of Cengage Learning, is an e-research and educational publishing database for libraries, schools, and businesses. It is a source of reference content as well as an easy-to-use organization of full-text magazine and newspaper articles. GALE creates and maintains more than 600 databases that are published online, in print, as eBooks and in microform. Gale also licenses its proprietary content for integration within web-based information services.
- **JSTOR** was founded in 1995 to build trusted digital archives for scholarship. Today, JSTOR works with the scholarly community to preserve their work and the materials they rely upon, and to build a common research platform that promotes the discovery and use of these resources. With participation and support from the international scholarly community, JSTOR has created a high-quality, interdisciplinary archive of scholarship, is actively preserving over one thousand academic journals in both digital and print formats, and continues to greatly expand access to scholarly works and other materials needed for research and teaching globally.

- **PROQUEST** creates specialized information resources and technologies that propel successful research, discovery, and lifelong learning. ProQuest offers the expertise of such respected brands as CSA™, UMI®, Chadwyck-Healey™, SIRS®, and eLibrary®. With Serials Solutions®, Ulrich's™, RefWorks®, COS™, Dialog® and now Bowker® part of the ProQuest brand family, the company supports the breadth of the information community with innovative discovery solutions that power the business of books and the best in research experience.

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