Educational Software Requirements Elicitation Techniques: Including Children with Autistic Spectrum Condition

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Abstract: Although specialized literature and software engineering frameworks suggest techniques for elicitation of software requirements, no elicitation technique works for all situations. Challenges arising from end users' communication disabilities make choosing an adequate technique even more important to identify these users' usability and accessibility needs and preferences. Children with such disabilities, e.g. Autistic Spectrum Condition (ASC), are particularly challenging. The literature on software requirements elicitation for children with ASC seems particularly scanty. Here, systematic mapping studies of the literature, analyses of some software development frameworks and recommendations from practicing software engineers were considered to create an initial catalogue of elicitation techniques. Specialists on software and autism were then invited to evaluate the applicability of each of the catalogued techniques for children with an ASC. This paper brings results of such evaluation. As such it may assist software requirements engineers in selecting techniques that are more likely to successfully include children with ASCs in the requirements elicitation process. Future work could experiment with such techniques in (educational) software development contexts.

1 INTRODUCTION

Poor definition of requirements is among the main causes of software development failure (Standish Group Int., 2015). Poor requirements can result from software engineers' inadequate choices of elicitation techniques (Sabariah et al., 2019). An erroneous choice can influence the elicitation results and thus degrade the quality of the collected requirements and have a negative impact on the final software product. In the case of educational software, the impact can be passed on to the stakeholders' education (Sabariah et al., 2019).

The choice of which technique to use can be more complicated when one deals with stakeholders who have conditions such as autistic spectrum conditions (ASC), attention deficit hyperactivity disorder (ADHD) or Down syndrome (DS), which affect about 15% of the world's population (WHO, 2021). Such conditions can include one or more impairments such as communicative, cognitive, developmental, intellectual, mental, physical, or sensory condition, or a combination of these.

This paper focuses on techniques for eliciting educational software requirements from children with ASC (Autistic Spectrum Condition) because this condition may make the elicitation process more

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challenging, since it affects social interaction, communication, interest, and behavior (Logan et al, 2022). The severity and impact of ASCs vary significantly. As noted by an early reviewer of this work [private communication, June 2019], "children with high-functioning ASC can be articulate and could potentially provide well specified requirements; a low-functioning child with ASC will not even be able to talk". Similar observations have been reported by Beutel et al. (2021). This is the reason why the researchers decided to target children with medium -to high- functioning ASC. Further, the literature on elicitation techniques for communication-challenged stakeholders is limited.

Some studies in this field detail the requirements of an application which should be met to assist the needs of children, but the main challenge is that children are not included in the requirements elicitation stage of the development process, only in the validation process (Giullian et al., 2010). The inclusion of stakeholders in the requirements elicitation process should be one of the most important factors in order to determine the success of a software application (Sadiq & Jain, 2014). Of course, relatives and professionals – e.g., caregivers and educators working with children with an ASC – may understand some of the needs and difficulties of the children (Cheak-Zamora et al., 2015). However, the children's participation in the process can bring a more complete perspective of necessary requirements to an application, enhance the quality of the application and therefore become more beneficial to the user.

This paper describes the research results from an evaluation of techniques and/or practices that help to elicit requirements for educational software applications aimed at children with ASC. The discussion herein is meant to help guide developers of specialized educational software applications ("EduApps") for ASC users. The results can support the decision-making process of the selection, combination or adjustment of EduApps' requirements in order to better reflect the needs of users with ASC.

2 RELATED WORK

The literature is rich in articles that seek to guide the elicitation process of software requirements. However, consensus exists that one elicitation technique cannot work for all situations. For this reason, papers and books on of the requirements of engineering describe multiple requirements elicitation techniques relevant to varied situations. Gobov & Huchenko, (2021) have interviewed hundreds of IT and business analysts about the applicability of elicitation techniques used in software development projects in corporations (companies). Although their work does not specifically address educational contexts nor ASC users, it does highlight recent information on characteristics of elicitation practices and techniques which the authors of this paper had gathered and analyzed earlier and deemed to be suitable for ASC users.

Interest in developing software applications for users with ASC is on the rise with a good number of recent papers published (Cabanillas-Tello & Cabanillas-Carbonell, 2020) – most of which concentrate on the applications themselves, i.e., guidance on "what" or which requirements to develop (Aguiar et al. 2020; Zubair et al., 2021). They do not seem to ask the question "how" or whether the elicitation technique could include ASC users in the development as it is of interest here.

Francis et al. (2009) discusses the issue of involving users with autism and Asperger's in the design of assistive technologies. The main challenges they found were concerns around misunderstandings and difficulties in clarifying misconceptions.

Antona et al. (2009) have evaluated a set of methods and techniques applying two criteria: disability and age. In their work cognitive and communication challenges were included among the disabilities and a comparison of 12 requirements elicitation techniques was made based on literature studies. It can be noted that those comparisons did not take the opinion of specialists into account.

Some studies propose an inclusive design approach in order to develop therapeutic games for children with disabilities – e.g., (Malinverni et al., 2016). The methods applied present strategies to integrate the expertise of clinicians, contributions from children and the experience of designers through a set of elicitation and merging techniques.

Sabariah et al. (2019) plan a framework for eliciting requirements of applications for teaching children. They note that it is important to select an elicitation method that is aligned with children's characteristics, age in particular, but do not consider the special needs of children with ASC, as done here.

Recent exceptions of attempts to consdier ASC children's needs include two reports. One, by Pinheiro et al. (2020) report on an ad-hoc method they used for the elicitation of interface requirements. Another, by Groba et al., (2021), included ASC users as direct contributors into their work albeit without discussing characteristics of the specific elicitation

techniques. Reflecting the specialized literature, these two reports do not explicitly discuss selection of elicitation techniques for education software applications (EduApps) aimed at ASC children. They, however, provide information for validation experiments of interface requirements for mobile apps aimed at ASC users.

Melo et al., (2021) advocate the elicitation of general software requirements for low-functioning users with ASC. The authors propose two artifacts (a set of questions to interview users and a canvas model to synthesize interview results) to be integrated into the elicitation techniques. The artifacts were designed with assistance from developers and caregivers, in a complementary way to our research.

In this research we concentrate on how software engineers may include a marginalized group of users through elicitation techniques and other interactions adapted to the needs of ASC children. Typically, theonly advice from ASC children's well-meaning "proxies" (e.g. parents and carers) have been considered in the software development (specification) process. We evaluate the applicability of techniques and/or practices to elicit requirements of EduApps for children with ASC. The evaluation is carried out with the assistance of parents, caregivers and educators who work with children with ASC and of software engineers who have had some professional experience with these children.

3 RESEARCH METHODOLOGY

Results were produced following a 6-step methodology:

1. A structured, systematic review of the literature, analyses of some software development frameworks, and recommendations from practicing software engineers who were employed to compile an initial catalog of elicitation techniques was catalogued.
2. Depending on the means of elicitation used (conversation, observation, documentation, analysis, and synthesis), the catalogued techniques were sorted into four classes: conversational, observational, analytic, and synthetic.
3. Once the catalogued techniques were classified, an initial questionnaire on the applicability of each technique to elicit requirements of EduApps for ASC users was prepared for evaluation and possible adjustments by a group of (pretest) participants who work with children with ASC.
4. Pre-test participants were interviewed to evaluate the pre-test questionnaire. First, they were informed by the interviewer on the research and its objectives; next, they received explanations on the catalogued techniques; and then, they were asked to fill out a questionnaire. The participants could clarify any questions and doubts they had with the interviewer. The interviewer took notes of required / recommended changes that would help to the enhance the quality of questions.
5. The questionnaire was adjusted as required, an introductory briefing on the research was included and a respondent's (participant's) qualification section plus a consent form was added. The questionnaire was then made available to a second group of (test) participants – some of whom answered it independently online, while others participated in questionnaire-structured interviews.
6. Test results were collected and analyzed to provide insights into how to include children with ASC in educational software requirements elicitation.

Ethical approval for the research was received from Paraíba State University's (UEPB's) Research Ethics Committee, Campina Grande, PB, Brazil, under Number 090469/2019. No participant was compensated financially or otherwise.

Fortunately, sessions where close human contact was required were conducted before the Covid-19 pandemic. Later activities of revision, completion, updates, and validation of results for each step were carried out in a way (e.g., by recent literature review and comparison) that safeguarded participants.

Each methodological step is detailed next.

4 CATALOG OF TECHNIQUES

Four digital literature libraries were searched, and relevant publications collated to produce a catalog of useful elicitation. The libraries included: [1] ACM Digital Library, [2] IEEE Xplore Digital Library, [3]Scopus, and [4]Google Scholar. These libraries were chosen because of their wide coverage of engineering related topics. Subsequently, conference proceedings, journals and book chapters were studied and

[1] https://dl.acm.org/

[2] https://ieeexplore.ieee.org/Xplore/home.jsp

[3] https://www.scopus.com/

[4] https://scholar.google.com/

analyzed. The review was structured around the following search string:

("elicitation" OR "requirements elicitation" OR "requirements gathering" OR "requirements acquisition") AND ("technique" OR "approach" OR "method" OR "practice")

The search string was applied in accordance with the digital libraries search mechanism and may be adapted to execute properly.

Each technique (article) in the resulting database was evaluated to decide whether it should be selected for the research related catalog. Evaluation was carried out in 5 stages: (Stage 1) Initial Search: Collection of all the articles returned by the searches of the databases. A total of 3.856 articles were returned from searches. (Stage 2) Exclusion by title: Exclusion of duplicate articles, articles that did not have a full version available, articles that were not related to the research, articles that were not published in English. After this stage, 457 articles remained. (Stage 3) Exclusion by abstract: Exclusion of articles that were not within the scope of this research. After that, 115 articles remained. (Stage 4) Exclusion by diagonal reading: Reading abstract, introduction, figures, and conclusions. After that, 67 articles remained. (Stage 5) Exclusion by complete reading: Complete reading of selected articles. Finally, 31 articles remained.

For a minimum level of quality, each of the 31 remaining articles underwent an evaluation based on 4 criteria: (C1) Does the work clearly define its research objective? (C2) Does the work sufficiently discuss the proposed/cited elicitation techniques or merely mentions them? (C3) Does the work carefully consider results of the elicitation technique discussed? (C4) Does the work address more than one elicitation technique? After applying C1 to C4 to the 31 publications, only 12 remained left for our study (Table 1).

4.1 Data Extraction

The requirements elicitation techniques cited in the 12 articles were extracted for analysis and interpretation. Note that a given selected article may yield one or more techniques. Techniques that are applicable only to specific contexts, different from the one of interest here (inclusion of children with ASC) were excluded. In addition, we also excluded techniques that derived from already selected techniques or otherwise would not produce new insights towards the research, because they just underwent operational changes – e.g., automation.

After listing the techniques, the most frequent ones were identified. The main criterion for classifying a given technique as "frequent" was the number of references to it found in the literature and based on the opinions of two participating software engineers. As a result, a catalog of 23 potentially applicable elicitation techniques was produced as shown in Table 2. Details on each of the 23 techniques in Table 2 may be found in any of the referenced studies (E1 to E12) in Table 1.

Newer literature searches (January 2022), including CSEDU 2021 publications, indicate that the catalog in Table 2 reflects current practices comprehensively and its contents correlate with those of recent articles, and in special, the elicitation techniques in the survey by Gobov & Huchenko (2021),. Most recent research and development (R&D) efforts seem to concentrate on making existing techniques more efficient through automation or gamification – e.g., (Kengphanphanit & Muenchaisri, 2020; Dar, 2020), thus suggesting a research gap that may be filled by our findings.

Table 1: Selected Articles.

Code	Reference	Type of work
E1	Al Mrayat et al., 2014	Comparative Study
E2	Zhang, 2007	Comparative Study
E3	Zowghi & Coulin, 2005	Survey
E4	Goguen & Linde, 1993	Survey
E5	Nuseibeh & Easterbrook, 2000	Overview
E6	Ramingwong, 2012	Review
E7	Saeed et al., 2018	Review
E8	Sharma & Pandey, 2013	Review
E9	Hoffman et al., 1995	Review
E10	Cooke, 1994	Review
E11	Khan et al., 2014	Systematic Review
E12	Pacheco et al., 2018	Systematic Review

5 CLASSIFICATION

The techniques in the catalog are classified (Zhang, 2007) as conversational, observational, analytic, or synthetic, depending on the specific manner in which software requirements engineers interact with other software stakeholders, in particular end-users. Classifying the techniques helps developers comprehend various elicitation alternatives and select a suitable technique for a given requirements elicitation context – e.g., EduApps. Classification

will support the comparisons of the results of our study.

5.1 Conversational

The techniques in the conversational (or verbal) class provide a means of verbal communication between two or more people. Conversation is a natural way to express needs and ideas, and to ask and answer questions. Classification is effective in developing and understanding problems and help eliciting generic product requirements (Zhang, 2007).

In general, conversational strategies are often used in requirements development, however not on their own: they usually need to be combined with other techniques (Al Mrayat et al., 2014). Considering the peculiarities of children with ASC, conversational techniques seem less likely to be recommended for the context of interest here.

Table 2: Classes of techniques for eliciting software requirements.

CLASS	TECHNIQUE	STUDY												MODE			MEDIAN		
		E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	IT	NON-IT	OVRALL	IT	NON-IT	OVRALL
CONVERSATIONAL	Interview	X	X	X	X	X	X	X	X	X	X	X	X	4	4	4	4	4	4
	Questionnaires			X	X	X	X	X	X	X	X	X	X	1	2	1	1.5	2	2
	Group work	X	X	X	X			X		X				4	4	4	4	4	4
	Brainstorming	X	X	X		X	X	X	X	X				4	4	4	4	4	4
	Role-Play										X			5	4	4	4.5	4	4
OBSERVATIONAL	Social Analysis	X	X											5	4	5	5	4	5
	Protocol Analysis	X	X	X	X	X			X	X		X		3	4	3	3.5	4	3
	Discourse Analysis				X	X	X		X					4	5	5	4	4	4
	Apprenticing			X				X						5	4	5	5	4	4
ANALYTIC	Documents analysis	X	X	X		X	X	X	X	X			X	3	4	3	3.5	3	3
	Task analysis			X				X	X	X	X	X		4	4	4	4	4	4
	Requirements reuse	X	X						X					2	4	4	2.5	3	3
	Laddering	X	X	X		X			X		X	X		3	4	3	3	3	3
	Card sorting	X	X	X		X		X	X	X	X			2	4	4	2	4	4
	Repertory Grid		X	X		X			X	X	X	X		3	4	4	3	4	4
	Decision analysis									X	X			3	4	4	3.5	4	4
	Introspection			X	X				X			X		-	5	5	2.5	4	4
	Soft System Analysis								X					3	4	4	3	4	4
SYNTHETIC	Scenarios	X	X	X				X			X	X		5	4	4	4	4	4
	Prototyping	X	X	X		X	X	X	X			X	X	5	4	5	5	4	5
	Joint Application Development	X	X	X	X	X		X	X					-	4	4	3.5	4	4
	Throwaway Paper Prototype								X					3	4	4	3	4	4
	Proximity Scaling Technique								X		X	X		3	4	4	3	4	4

5.2 Observational

An observational technique provides a means to develop a rich understanding of the application domain by observing human activities (Zhang, 2007).

Some requirements may be apparent to stakeholders, but rather difficult to verbalize. These are called tacit requirements. Verbal communication is frequently weak when gathering tacit requirements. As a consequence, observing how people perform their regular work can facilitate the collection of necessary information without the users actually having to explain their actions in words.

5.3 Analytic

Analytic techniques provide ways to explore existing documentation or knowledge to acquire requirements from a series of deductions. The knowledge implied even if not directly expressed, such as the expert's knowledge or the information about regulations or legacy products, also provides engineers with rich information about a product. Analytical techniques are usually time-limited and task-limited and are used only once to solve a specific issue.

Generally, analytic strategies are not essential to requirements elicitation, because they could potentially be obtained from sources other than the clients (end-users) themselves. Nevertheless, they form secondary variants that enhance the performance and applicability of requirements elicitation. This is particularly relevant when heritage-based information or other relevant products are reusable (Al Mrayat et al., 2014). This is information one receives ("inherits") from apps that have been in use and need to be passed on for (co-)processing by the new app being designed.

5.4 Synthetic

According to Browne and Ramesh (2002), synthetic techniques incorporate various channels of communication and offer models to illustrate the characteristics and relationship of a system. As such they can indicate requirement recognition, in the form of abundant semantic models. As the purpose of synthetic techniques is to enhance the communication between programmers and users, they are appropriate for various different phases of the software development process (Al Mrayat et al., 2014).

6 EVALUATION

The pretest questionnaire was evaluated by a group of 11 interviewees: 8 health professionals, 2 educators and 1 software engineer.

The adjusted, online (test) questionnaire had 23 closed questions (one for each technique in Table 2). For each technique, the respondents were asked to indicate the level of their (dis-)agreement (in a 5-point Likert scale) with a statement of the suitability of the technique formulating elicitation requirements for medium- to high- functioning ASC users. This way, all interview participants answered the same questions by choosing from the same answer options to yield more consistent results (Alencar, 1999). Each response option was assigned a qualitative and a quantitative scale: strongly disagree (1), disagree (2), neutral (3), agree (4) and strongly agree (5). At the end of the questionnaire, respondents had the option to offer suggestions or more details (e.g., reason) for their answers as discussed later in this section.

The 5-point Likert scale allowed for rankings of the techniques in terms of their perceived adequacy in regard to elicitation of EduApps requirements. Note however, that the intervals between consecutive values cannot be considered equal. Using the mean (and standard deviation) of the response values is thus inappropriate for the resulting data. As suggested by Boone Jr. and Boone (2012), the mode and the median are used here as evaluation measures.

Additionally, different weights may be attributed towards the impressions of different respondents in order to reflect the participants experiences with ASC. For instance, a parent's impression may weigh more, than a software engineers'. In case a respondent is said to come from class c ∈ C = {Parent, Educator, Psychologist, Social Worker, Software Engineer}, one could use as evaluation measure, the Weighted Median (WM) or the 50% weighted percentile - proposed by Edgeworth (1888). For n distinct, ordered respondent classes $c_1, c_2, \ldots, c_n$ with respective positive weights $w_1, w_2, \ldots, w_n$ such that $\sum_{i=1}^{n} w_i = S$, the WM is class c_k that satisfies inequalities 1.

$$\sum_{i=1}^{k-1} w_i \leq \frac{S}{2} \quad and \quad \sum_{i=k+1}^{n} w_i \leq \frac{S}{2} \tag{1}$$

For simplicity but without loss of generality, we assume equal weights in this study.

The test questionnaire was answered online by 19 respondents: 6 parents of children with medium- to high-functioning ASC, 5 health professionals, 4 educators and 4 software engineers. Among the

respondents 94.7% had professional experience with children facing some cognitive difficulty which impairs communication and 78.9% had experience with children with ASC. The professionals who participated in our research had been practicing their professions for an average of 9.13 years, with a minimum of 6 months and a maximum of 20 years. Table 2 shows the Mode and Median of the quantitative values of their responses for each of the 23 elicitation techniques. We calculated the measurements separately for IT professionals (developers) and non-IT in addition to overall measures.

Non-IT professionals (in this case, parents, health professionals and educators) who work with children with ASC seem to be (naturally) too favorable of these children's ability and willingness to play a software client. Software engineers (synonymously called developers or IT professionals here) seem to have a less favorable view as results illustrate. In fact, in 18 of the 23 techniques, the median for IT professionals was lower or equal than for non-IT professionals (see Table 2). An aspect worth noting was the low evaluation of the Requirements Reuse and Introspection techniques by IT professionals. These two techniques give the software engineer a greater freedom in relation to the requirements Because the programmer decides on the requirement by herself, without consulting the end-user. In the case of Introspection, the analysts work out how a system design should be put into practice by themselves without any input from the end-user. This negative evaluation may be the result of IT professionals believing that they are not in the position to define the targeted (children with ASC) user needs without additional information.

Even when the overall average of each class is considered, as expected, the techniques classified as conversational have a lower average than the other classes (Conversational = 3.6; Analytic = 3.7; Observational = 4; Synthetic = 4.2;). As discussed earlier, conversational techniques are characterized by verbal communication between two or more people. Therefore, respondents believe that children with ASC will not find these techniques attractive.

In addition to the 23 closed questions, the test questionnaire included 2 groupings of open questions:

1. - How would you rank the 23 techniques in decreasing order of the applicability potential?
- Which characteristics of the techniques (would) make them more (or less) adequate to elicit requirements of software for children with ASC?
2. - Do you believe that adjusting or mixing some of the techniques would make it easier to elicit requirements of software for children with ASC?
- Which techniques and which adjustments come to your mind?

Answers to these 2 groupings of open questions are summarized next.

6.1 Ranking of Techniques

By analyzing the rankings performed by the respondents answering the first open question, a series of highly ranked techniques became apparent: Group Work, Prototyping, Apprenticing, Social and Discourse Analysis. As expected, the techniques with high value of mode and median were positioned at the top.

For the Group Work technique, groups are brought together to discuss some topics of interest with their researcher. In market research, this is often accomplished by using stimulus materials such as videos, storyboards, or product mock-ups as a focus, and is commonly applied to receive opinions on new products from a group of selected potential customers (Goguen & Linde, 1993). The idea of using visual materials to stimulate the responses of opinions was one of the factors that resulted in this particular technique to show a high level of agreement amongst participants. Indeed, our newer literature searches revealed that this idea is already being successfully explored: the work of Zhu et al., (2022) mentions experiments that use this technique, making use of drawings with a group of six ASC adolescents.

Although the Prototyping technique was ranked positively, it is important to point out that to build the prototype to show the end-ser one need to have a set of requirements – which may have been defined by the software engineers themselves and not by the end-user. The end-user would be biased by what is presented to him. As such, this seems a more appropriate technique for the validation of a set of requirements.

Regarding the Social and Discourse Analysis, many of the participants stressed the need to understand the social and cultural context surrounding the child, and the fact that such techniques do not require a direct response from the child. On the other hand, it was pointed out that simple analysis may not often elucidate the reasons for a child's behavior and attitudes, given that each child is unique in the way they address levels of difficulty?

The respondents took into consideration whether there was a need for the child to read and interpret texts to receive a clearer picture of the level of difficulties. In this context, techniques such as

Questionnaire and Repertory Grid ended up being ranked negatively, especially considering that children with ASC, in general, do not concentrate on a particular subject for long. The need to describe actions while performing an activity in the Protocol Analysis technique was considered unfeasible, given the fact that children with ASC sometimes have great difficulties in expressing themselves clearly.

6.2 Adjusting and Mixing Techniques

After the analysis of the open question answers it became clear that modifications and adaptations were required in order to implement modified techniques and apply them to our target audience. Some suggestions for adaptations were found to be more general, i.e., they could be applied to more than one technique, such as:

(a) Ask the user to point, observe her/his body language or other type of communication instead of (or in addition to) speech. In the case of techniques such as Interviews, Questionnaires and Brainstorming, the response necessary to extract information from the child can be given through expressions or gestures replacing the need for verbal communication.

(b) The use of images will facilitate a better understanding of the children. If the technique requires the child to perform some activity, this activity should be described and explained through images, facilitating the child's ways of understanding. In addition, when using techniques that present some information to children through lists or cards, such as Card Sorting and Repertory Grid, the information should also be presented via images.

(c)More direct commands. Techniques that involve analysis such as Social Analysis, Discourse Analysis, Task Analysis and Decision Analysis, require the software engineer to provide the child (user) with more specific and direct commands in order for the child to understand and perform.

Before initiating an activity such as Group Work, participants highlighted the need to introduce the children to the session schedule and planned activities. This will be particularly important for the design of interview sessions with the child to prevent disruptions of their normal daily routines. In these Group Work activity sessions, techniques, such as Throw-away Paper Prototype, Task Analysis and Discourse Analysis can be used as part of the activity to obtain more information from the children.

An interesting and thought-provoking suggestion from the respondents was to ask the software engineers to first experiment themselves with particular tasks that the user with ASC would have to perform. This way the software engineer will be given an opportunity to imagine how it would feel to be a child with ASC. The experiment should be under the supervision of a therapist expert on ASC to determine, guide, comment, adjust tasks the software engineer is to perform, much the same way ASC kids are supervised. To understand the excess of sensory stimuli that the child with ASC routinely experiences, the software engineer could perform elicitation in a stressful environment, for example in a room that is too cold, hot, bright, noisy, full of frequent interruptions and distractions), or to receive orders and commands from a therapist so that the interactions with the therapist are deliberately confusing, incomplete or plainly meaningless. This type of experience might enable the engineer to better develop techniques such as Learning, Reuse of requirements and Introspection.

7 THREATS TO VALIDITY

One external limitation to the generalization of our study is the validation sample size. Although we obtained valuable information and insights from 30 (11+19) participants, they may not be representative of the larger population. As research efforts about requirements needed for the software development aiming at ASC children continues, information and insights from more experts may be needed. It is worth noting however, that this threat was somewhat mitigated by engaging with participants that have an average of close to 10 years' experience in working with ASC children.

Another external limitation to generalization regards the underlying research methodology. The methodology may be applicable to requirements of software in general, but the use of parents who prioritized educational software (vs. entertainment software such as games) and validators who specialize in educating children with ASC implicitly sets the context of the paper to that of educational software for children with ASC. On the other hand, discussions, results, and guidelines for software development sighted in related work - e.g., (Zhu et al., 2022; Aguiar et al., 2020; Silva & Teixeira, 2019) provide evidence that the insights and recommendations made through this study align well with those made by other researchers.

Another limitation observed is that some information in the consent form or provided in introductory briefings may have given unintended hints about the research intentions and expectations.

This could have led to what is called hypothesis guessing where participants respond to questions based on what they think the researcher wants to hear. Another threat is that, despite providing explanations to the participants that some non-IT professionals amongst the participants may not have been familiar with terms and definitions of requirements engineering, thus they might have given some answers without a very clear understanding of the topic at hand.

Yet another threat to internal validity is the risk that our searches of the literature and filtering procedures may have missed or discarded material that should have been considered. Backchecking filtered results, scanning references lists of considered articles and repeated new searches may have reduced such risks, but not eliminated it.

8 CONCLUSIONS, NEXT STEPS

This paper collated elicitation techniques from the specialized literature into a catalog of classes of common and current techniques and practices. A team of parents, experts in the care, education, and software development for children with autistic spectrum condition (ASC) evaluated and ranked the catalogued classes of techniques according to their adequacy for the context of educational software.

Findings indicate that when perceptions of team members are attributed equal weights the most adequate techniques were Group Work, Prototyping, Apprenticing, Social and Discourse Analysis followed by techniques such as Questionnaires. Participants also suggested that the use of visual artifacts such as drawings would help to make the process of feedback more accessible to children with ASC. These findings correlate well with recent R&D efforts to build more attractive (educational) applications for ASC users. Findings contribute to requirements engineering since they may guide developers in selecting the most adequate techniques for eliciting software requirements from ASC children. One pragmatic recommendation that comes out of this study is that software developers should try out working in simulated stressful working conditions so that they can empathize better with ASC children.

Findings offer evidence that there are ways to include children with ASC in the educational software requirements elicitation process. The research reported in this paper creates paths for future research and the practical use of results to manage the development of educational software tools for children who are on the ASC spectrum.

Next steps in future work on the paper's topic could experiment with hybrid or adjusted elicitation techniques based on respondents' suggestions and to include children on the ASC spectrum, not just their well-meaning proxies.

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