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Factors Influencing Intention to Introduce Accessibility in Makerspace Planning and Implementation

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Makerspaces continue to grow in popularity in public, academic, and school libraries. As makerspaces are included in library services, accessibility for all users is important. What motivates a school librarian to implement a makerspace accessible to all learners? Are they more likely to invest in accessibility if provided the necessary resources? In this study, researchers discuss which Theory of Planned Behavior (Ajzen 1985) variables significantly predict school librarians' intentions to implement accessible makerspaces. Researchers also delve into how attitude towards accessibility in makerspaces influence the intention to implement accessible makerspace. Findings indicate identifying perceived behavior control is the principal predictor of behavioral intention. Additionally, identifying makerspace accessibility as a top priority and agreeing that it should be accessible might be different in the minds of school librarians.

Introduction

Makerspaces have taken libraries by storm and become a mainstay in many public, academic, and school libraries. While no two makerspaces are the same, in school libraries, maker services and other offerings can include technology such as laser cutters, music studios, and computer programming (Moorefield-Lang, 2015a). Because the focus tends to be on technology, research has largely addressed many issues associated with the implementation of various devices such as 3D printers and other technology-based devices (Canino-Fluit, 2014; Moorefield-Lang, 2014). Other topics of research on makerspaces in school libraries include legal issues such as user agreements (Koh & Abbas, 2015; Moorefield-Lang, 2015b), professional development and competencies for staff (Oliver, 2016), best practices (Fleming, 2015), and literature and social media attitudes toward makerspaces (Willett, 2016).

Makerspaces have increased access to technology and a wider range of hands-on learning experiences over the last decade, but the accessibility of the actual makerspaces has been called into question (Steele, Cakmak, & Blaser, 2018). People with disabilities make up 13% of the population (National Science Foundation, 2017). When a school librarian decides to implement a makerspace into their library, are they creating the space for all learners? Are they making the space accessible for all students in the learning community regardless of ability? What barriers exist in making a school library makerspace accessible?

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In this research study, we investigate intention as school librarians implement makerspaces in their libraries and plan activities for their spaces. Due to the absence of literature on this topic, the authors believe this research is an effective first step in determining behaviors which influence school librarians to consider introducing accessibility into makerspace design. The following research questions frame this study:

- R1: Which Theory of Planned Behavior (Ajzen, 1985) variables significantly predict school librarians' intentions to implement accessible makerspaces?
- R2: How does attitude toward accessibility in makerspaces influence the intention to implement an accessible makerspace?
- R3: How does subjective norm influence the intention to implement an accessible makerspace?
- R4: How does perceived behavioral control over mastering accessibility issues influence the intention to implement an accessible makerspace?

Review of Literature

As makerspaces continue to grow in popularity in library settings, researchers want to understand their use and impact in educational and library settings (Bowler & Champagne, 2016; Moorefield-Lang, 2014; Slatter & Howard, 2013). Makerspaces, fab labs, and hackerspaces are ever-growing topics of research. The body of knowledge continues to increase across empirical publishing platforms as well as through popular venues like magazines, popular library journals, blogs, vlogs, webinars, and zines.

A discussion on fully accessible makerspaces must include the idea of accessibility. It is a word used and interpreted differently depending on the context and design approach being used. Persson, et al. (2014) discusses universal design and accessibility benefits across individual, economic, and societal levels; accessibility being designed for the most benefits to the widest audience. One aspect of literature on accessibility in makerspaces in libraries delves into community based issues such as organizing accessible events in makerspaces (Brady et al., 2014), which are vital in engaging users that would otherwise be excluded from using technology and services offered on a day to day basis. Beuhler, Kane, and Hurst (2014) discuss 3D printing in special education and the opportunities that rapid prototyping provides in the understanding of basic concepts. These authors also write on the obstacles with this technology especially in the area of software and execution of design.

Another area of scholarship, particularly in the field of Interior Design, focuses on the layout of makerspaces for accessibility. Makerspaces as a learning location typically offer a wide range of options in technology and creativity, but those spaces lose their influence if they are not accessible to all (Steele, Cakmak, & Blaser, 2018). Authors also recommend the idea of a space that is mixed ability, where a collaborative culture of those with and without disabilities can work together (Alper, 2013). An important aspect is to include the community in which technologies, tools, and activities should be in a makerspace. Feedback on layout and design is also crucial (Moorefield-Lang 2019; Steele, Cakmak, & Blaser, 2018). This aspect of makerspaces, libraries, and design has been deemed important in the existing literature of accessibility of a makerspace.

Current research lacks studies dealing with what motivates school librarians running and designing makerspaces to consider making them accessible. To fill this gap in the literature, the current study examines factors influencing behavioral intention to implement accessible makerspaces in school libraries. Ajzen's Theory of Planned Behavior (TPB) grew out of his previous

work on Theory of Reasoned Action. The theory was chosen for the current study because it rests on two crucial assumptions: human behavior is intentional and goal directed (Ajzen, 1985) and the decision to introduce accessibility to makerspaces is both. In its most basic form, TPB proposes that behavioral intention will be affected by attitude toward a behavior, social norm, and perceived behavioral control.

For instance, the intention to adopt a certain behavior or take an action would be influenced by approval of significant others, consideration of consequences of an action, and costs of action versus inaction. Examples from education literature include a wide variety of research topics from educational interventions (Jalambadani, et al., 2017; Mohammadi Zeidi, Pakpor & Mohammadi Zeidi, 2017), and learning and teaching (deFeijter et al., 2012; Reyes et al., 2013) to student attitudes toward education (Shen et al., 2012).

Similarly, the current study examines whether the intention to introduce accessibility into makerspaces is influenced by attitudes toward behavior (e.g., will making makerspaces accessible have positive or negative consequences), social norms (e. g., will friends, colleagues or significant others approve or disapprove of making makerspaces accessible), and behavioral control (e.g., will introducing accessibility into makerspaces be difficult or easy to perform). Other motivational theories such as Self-determination Theory (SDT) first proposed by Deci and Ryan (1980) were also considered. SDT is widely adopted in education studies and at its core proposes that all humans have a natural tendency to learn and grow. The role of education is to promote and foster that growth. Recent studies also involve library settings (Dubnjakovic, 2017). However, since the focus is primarily on interplay between motivation and basic psychological needs (i.e., competence, relatedness and autonomy) satisfaction, goal pursuit is considered in terms of how it affects the quality of motivation. For instance, altruistic and growth promoting goals foster intrinsic motivation while, materialistic goals promote development of extrinsic motivation. In contrast, the current study focuses on goal attainment (e.g., creating accessible makerspace), rather than how that would affect quality of librarians' motivation, and this focus is more accurately captured by TPB.

Methodology

Data Collection

A survey instrument composed of TPB items answered on a 7-point Likert scale and open-ended items was administered online in September 2019 using Qualtrics data collection software. The researchers provided a brief explanation at the beginning of the survey before the participants started answering the queries. This introduction briefly defined makerspaces, accessibility, the purpose of the survey, and how results would be used. The survey link was sent to several listservs serving targeted populations of school librarians in the United States of America. Association listservs in the survey administration included The American Association of School Librarians (AASL), The South Carolina Association of School Librarians (SCASL), The North Carolina School Library Media Association (NCSLMA), The Virginia Association of School Librarians (VAASL), The Tennessee Association of School Librarians (TASL), and The Kentucky Association of School Librarians (KASL). State association listservs were chosen due to convenience sampling, with the researchers having access to peers in the field willing to share the research study on their state's listserv. Social media such as Twitter and Facebook were also employed to distribute the survey for this study. Participation was voluntary and no financial or other incentives were provided for participation.

While there is no clear consensus regarding the minimum number of participants required for confirmatory factor analysis (CFA) or other structural equation modeling (SEM) procedures, for

normally distributed data reliant on maximum likelihood estimator, it is generally accepted that sample size of approximately 200 is sufficient, although many studies use considerably smaller samples (Gorsuch, 1983). The sample in the current study includes 116 participants whose experience running makerspaces ranged from 8 years (1.7%) to less than a year (13.8%). As seen in Figure 1, the largest category operated makerspaces for at least 2 years (21.7%). School librarians in the current sample served all grade levels. The largest group (37.07%) had makerspaces in elementary schools, while 27.59% worked in middle schools, 21.55% worked in high schools, and the smallest group (13.79%) taught in other school library settings. The “other” or more specialized library settings included wider grade range schools. Some examples included K-8 or full K-12 schools, these being particularly common in small, rural communities.

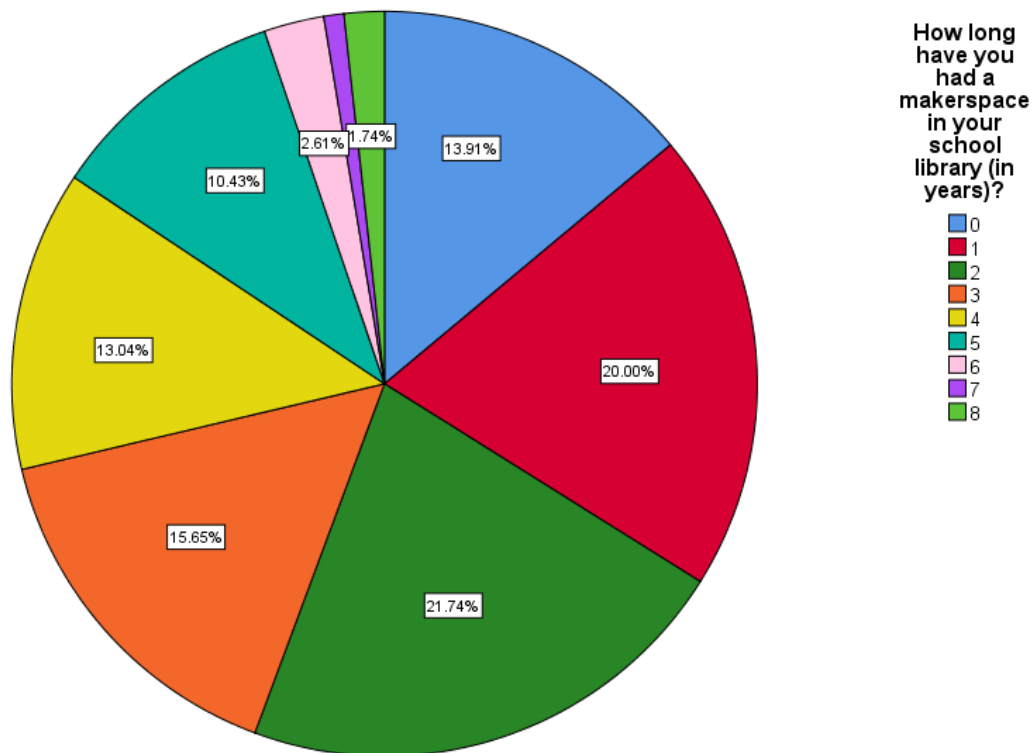


Figure 1. Librarian Makerspace Experience in Years

Measurement Instrument

Items representing TPB variables were adapted from Ajzen (1985). Additionally, open-ended questions designed to further assess accessibility in makerspaces and maker activities in school libraries were designed for this study. All items including the measurement scales are included in Table 1 and were scored on a 7-point Likert scale ranging from strongly agree to strongly disagree.

TPB construct	Items
Behavioral intention (BI)	I will work on making my makerspace more accessible. I will improve accessibility of my makerspace.
Subjective norm (SN)	My students believe accessibility is important for makerspaces. My faculty believe accessibility is important for makerspaces. My administrators believe accessibility is important for makerspaces. Parents in my learning community believe accessibility is important for makerspaces.
Perceived behavioral control (PBC)	I can secure the resources to make my makerspace more accessible. I can gain enough knowledge/expertise to make my makerspace more accessible. I can secure financial support to make my makerspace more accessible.
Attitude toward behavior (Att)	Accessibility is essential in a successful makerspace. I consider makerspace accessibility a top priority. A well-designed makerspace must be accessible.
Open Ended Questions	How do you physically set up your makerspace for accessibility? What types of accessible activities are offered in your makerspace?

Table 1: Measurement Scales: Items representing TPB variables

Data Analysis

Statistical Package for Social Sciences (SPSS) version 25.0 was used to conduct data screening prior to analysis as well as to create composite variables and conduct internal consistency reliability analysis for all unidimensional scales (i.e., BI, SN, PBC and Att). Linear Structural Relations software (LISREL) version 9.2. was used to conduct the structural equation model.

The full hypothesized structural model, presented in Figure 2, tested the relationships between the BI and SN, PBC and Att. According to TPB SN, PBC and Att will all positively affect BI. The strength of structural equation modeling over regression is that it allows for simultaneous analysis of all the variables in the model including interactions and measurement error is not a

significant contributor to the residual error term. This permits examination of more complex relationships than mere predictors and outcomes as is the case in regression.

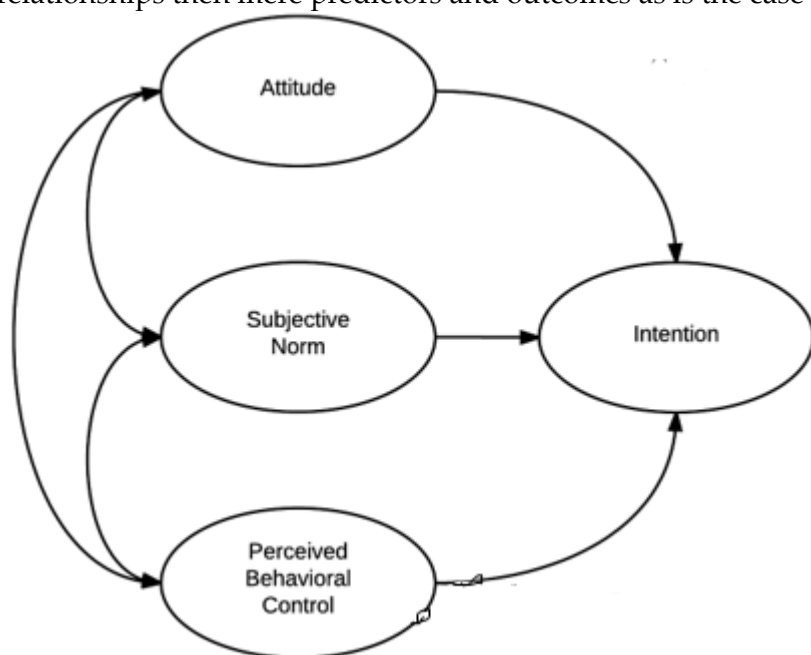


Figure 2. Conceptual TPB model

Open-Ended Questions

Content analysis was used for the qualitative portion, allowing the researcher to look at existing theories and instead of using pre-existing categories, delve into the themes emerging from the data (Hsieh, 2005). Content analysis can be used with raw material such as emails, text messages, and books. It can also be used, as is the case with this research, with open-ended survey responses. The researcher has the opportunity to determine the emphasis and where it lies within the data, seeking out emerging themes and trends (Marshall and Rossman, 2006). Open-ended survey questions were analyzed using NVivo 12 qualitative data analysis software. The first open-ended question queried accessibility of the library makerspace, while the second question sought information on accessible maker activities. Throughout analysis common themes were explored. Sample emerging themes from the open-ended survey results included layout, organization, and community.

Findings

R1: Which Theory of Planned Behavior (Ajzen, 1985) variables significantly predict school librarians' intentions to implement accessible makerspaces?

It was found that all TPB constructs significantly predict school librarians' intentions to implement accessible makerspaces. As seen in Table 2, all subscale items were well within the established skewness and kurtosis levels and part of a normal distribution and subsequently retained in the analysis. Reliability results (Table 3) indicate all subscales (i.e., attitude, subjective norm, behavioral intention and perceived behavioral control) exhibited acceptable levels of reliability with all alpha levels above the required 0.7 cut off point (Nunnally & Bernstein, 1994). Therefore, all items measure their respective constructs.

Scale item	N	Mean	SD	Skewness	SE	Kurtosis	SE
Att1	115	1.37	0.569	1.53	0.23	2.96	0.48
Att2	112	2.13	1.14	1.17	0.29	1.16	0.45
Att3	114	1.6	0.66	0.85	0.27	0.47	0.45
SN1	114	2.55	1.23	0.48	0.27	-0.5	0.45
SN2	114	3.2	1.26	0.42	0.27	0.23	0.45
SN3	113	2.9	1.4	0.6	0.23	0.2	0.45
SN4	114	3.3	1.2	-0.94	0.27	0.02	0.45
BI1	114	2.24	1.21	0.77	0.27	-0.27	0.45
BI2	112	2.2	1.22	0.91	0.23	-0.01	0.45
PBC1	115	3.1	1.53	0.68	0.23	-0.14	0.45
PBC2	114	2.3	1.12	0.77	0.23	0.21	0.45
BPC3	113	3.48	1.56	0.29	0.23	-0.7	0.45

Table 2. Scale descriptive statistics

Scale	N of items	Mean	Cronbach's Alpha
Attitude	3	1.71	0.73
Subjective norm	4	3.00	0.85
Behavioral intention	2	2.20	0.87
Perceived behavioral control	3	2.95	0.78

Table 3. Reliability results**Full model results**

Chi-square for the overall model was significant ($\chi^2 = 60.38$ df = 43, $p < 0.0411$), but other global fit indices support a well-fitting model (NNFI = 0.968, CFI = 0.979, GFI = 0.927, SRMR = 0.064, RMSEA = 0.056). As seen in Figure 3, all structural and measurement coefficients using the completely standardized solution are fairly high indicating a good fit. Modification indices (LISREL) indicated

additional paths from PBC 2 to Attitude and Att2 to Social Norm as well as correlated error terms between PBC1 and PBC3 and SN1 and SN4 resulting in significant model improvements. All coefficients were significant, and all paths were retained in the final model. In line with TPB, the model indicates there is a positive relationship between behavioral intention and attitude ($\beta = 0.12$, $p < 0.05$), social norm ($\beta = -0.36$, $p < 0.05$), and perceived behavioral control ($\beta = 0.97$, $p < 0.05$). This finding provides support for TPB in makerspace setting. Specifically, although school librarians were slightly more likely to consider making makerspaces accessible if their attitude toward making the change was positive, the largest impact was due to the amount of control they felt they had over making the necessary change. Given that the control in this case had to do with resources and training required to implement accessibility, this finding is expected, although perhaps not quite to this extent. In contrast, social norm in the form of perceived attitudes about makerspace accessibility regarding parents, administrators and students had a negative impact on this decision. This runs counter to TPB, and there are a number of possible explanations including possible lack of administrative support and any number of issues which should be further investigated. Behavioral control, social norm and attitude jointly accounted for 76.5% of variance on behavioral intention to construct accessible makerspace.

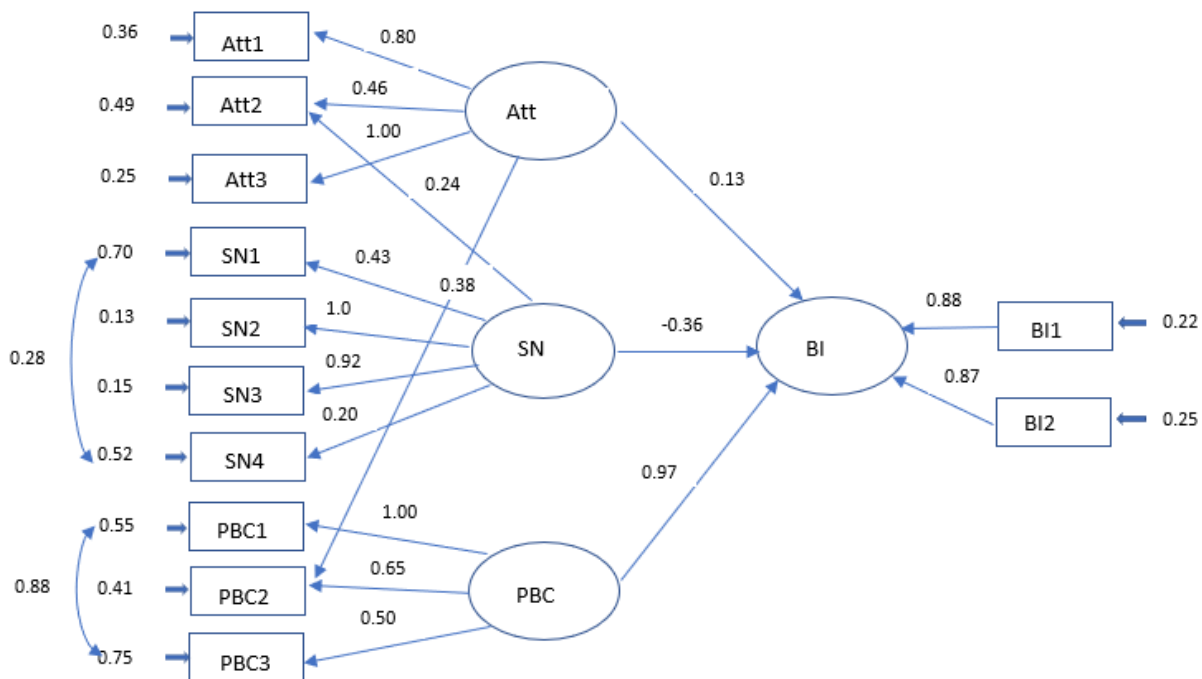


Figure 3. Full model

Open-Ended Questions

To complete the survey two open-ended questions were asked of the participants. The first requested information on how (if) study participants made their makerspaces accessible. The second question asked for information on accessible activities within the school library makerspace. Open-ended survey questions were analyzed using NVivo 12 qualitative data analysis software. The common themes for the question focused on how/if librarians made their makerspaces accessible were: activity, community, layout, organization, space, and storage. Responses from the first open-ended question are shared among the following research questions. Answers for the second question (accessible activities) were more varied. They are presented in Table 4. One respondent asked, “What

is an accessible activity?" This raises a good point. What makes an activity accessible? Is an activity more accessible than another; especially if directions are available in a variety of formats (video, braille, auditory) and supplies needed for each activity are provided for all abilities?

Low Tech	High Tech
Building: Legos, Keva Planks, KNex	Robots: Coding Robots, Spheros, Dash and Dot, Beebot
Book Page/Book Art	3D Printing
Crafting, Art, Drawing, Painting, Origami	Electronics, Snap Circuits,
Rainbow Loom Bracelets	Green Screen
Board Games, Checkers, Chess	Online Gaming/Gaming Design
Cardboard Creations	Engineering Competitions
Knitting, Crocheting	Coding Exercises

Table 4. Selection of Accessible Maker Activities Based on Survey Response

R2: How does attitude toward accessibility in makerspaces influence the intention to implement accessible makerspace?

Because of its wide applicability to a variety of situations and human behaviors, TPB has played a prominent role in behavioral research. Decades of research in psychology clearly points to the importance of personal attitude toward an action and its strong influence on behavioral intention. According to Ajzen (1985), attitude is a direct and necessary antecedent of behavioral intention. However, the exact degree to which behavioral attitude influences behavior varies greatly depending on research topic and context. Even so, the relatively small role (13%) attitude toward accessibility in makerspaces plays in the intention to implement these changes is somewhat puzzling. Looking at the composite mean of the three items designed to assess school librarians’ attitudes toward makerspace accessibility (1.71), school librarians clearly agree this is an important issue and a top consideration during makerspace design. As one librarian responded:

I'm always trying new ideas, and I run them past the students and faculty. I make sure I have all the necessary materials or access to them and let them get to work. My library is a pretty open sitting format which gives the students free thinking and moving.

Why then does attitude not play a larger role in behavioral intention? Looking at the individual attitude items provides valuable clues. Although alpha results point to a high reliability level (0.73) indicating these three items all assess makerspace accessibility attitudes among school librarians, when each individual item is correlated with behavioral attention, a more nuanced picture emerges.

Specifically, although all three items are positively correlated with the two behavioral intention items indicating that increases in the favorable librarians’ attitude toward accessibility also lead to increases in behavioral intention to design accessible makerspace, there are considerable variations across items. For instance, correlation between Att1 where librarians are asked how

essential they thought accessibility is in makerspaces exhibited a small positive correlation with behavioral intention (0.3). This number was even smaller for Att2 when they were asked if they considered it a top priority (0.2). However, when asked if they thought the makerspace should be accessible (Att3), the correlation, although still small, was much higher (0.4). Given that the highest correlation with behavioral intention concerned an item with arguably the most neutral wording, in terms of taking action, it is very possible that other competing priorities intervene and play a much stronger role in behavioral intention. In other words, identifying makerspace accessibility as top priority and agreeing that it should be accessible might be different in the minds of school librarians.

Again, given the high alpha level for attitude items, this is certainly not the only explanation for the relatively small role attitude plays in behavioral intention in this context, but it provides additional context and a possible reason for this result.

R3: How does subjective norm influence the intention to implement accessible makerspace?

Contrary to the TPB conceptual model, subjective norm had a negative impact on behavioral intention to implement accessibility in makerspaces. To begin to make sense of this result, it helps to consider the original item's meaning. Although by a relatively small margin, social norm had the highest mean (3.0) among all constructs. In other words, school librarians had the least confidence or at least only somewhat agreed that other important actors (i.e., administration, parents and students) considered accessibility an essential feature in a makerspace. As one librarian stated, "My administrators support my makerspace but are not promoters." Literature is largely silent on this point. While many studies point to multiple benefits of engaging families in makerspace activities (Barma, Romero & Deslandes, 2017), such as deepening bonds through knowledge sharing and making sense of technology across different generations, few if any focus on attitudes toward accessibility. Similarly, although it is to be expected that administrators would have positive attitudes toward accessibility in makerspaces, there is currently no research that explores this or in any way describes the way this support would manifest itself. Additionally, differing laws across states in the United States mandate certain accessibility accommodations administrators are required to comply with making it even more challenging to untangle their motivations and attitudes toward accessibility.

R4: How does perceived behavioral competence over mastering accessibility issues influence the intention to implement accessible makerspace?

Perceived behavioral competence was the most influential predictor of behavioral intention to implement accessibility in a makerspace in the current study to the extent that it could for all practical purposes be considered the sole predictor. Decades of motivation research in psychology clearly points to direct links between the ability to control outcomes and the resulting sense of mastery and sustained intrinsic motivation (Deci & Ryan, 2008). After all, given the steep learning curve and constantly shifting ground when it comes to designing a service as dependent on technology as makerspaces, the fact that perceived behavioral competence plays as strong a role in behavioral intention is hardly surprising. One librarian wrote the following about their fully accessible makerspace,

Equipment is accessible at wheelchair level. Wheelchair access to the library facility. Room to maneuver around equipment. Can/has been used with ESL students with student

assistance. Can/has been used with students with various disabilities including autism, emotional disabilities, etc. with student/staff assistance.

Designing the makerspace for accessibility or indeed designing it at all would require constant updating and monitoring, which in turn requires intrinsically motivated librarians. For only those who would consider the task rewarding would endeavor to maintain its accessibility and functionality. The sense of mastery and control over outcomes is one of the mechanisms that fuels the intrinsic motivation, thus completing the circle.

Conclusion

When implementing a makerspace, accessibility is important to the conversation. These learning environments provide a wealth of opportunities for students in school library settings. Making their learning experience fully accessible and universally designed creates a user-friendly learning environment where students can grow. This research study examined makerspace accessibility through the lens of Ajzen's Theory of Planned Behavior. While there are more research opportunities for the future, this study has opened the doors to intention and accessibility for a maker learning environment.

Future Research

The current study examines makerspace accessibility through the lens of TPB. Given the paucity of literature on the topic, the authors believe this is a necessary first step in determining which specific behavioral mechanisms influence school librarians to consider introducing accessibility into makerspace design. However, like most research the results raise other important questions yet to be explored in future research. For instance, school librarians' relationships with administrators, parents, and students need to be further explored in order to understand what could be done to improve and strengthen them so that the librarians could receive proper support needed to introduce change. Additionally, attitude played a very small part in motivating accessibility in makerspaces. Further research employing qualitative methodologies such as in-depth interviews would be better suited to elicit specifics from the respondents and is needed to understand these results.

As with all research there are limitations in this study. Accessibility is a universally desired quality in design of many services librarians offer and especially so in makerspaces whose very nature encourages collaboration between many different populations such as multigenerational families, teachers, students, and others. The current study focuses on makerspace accessibility in a school library setting and it should be replicated in public and academic library settings. Results would help tease out potential differences and/or similarities in librarians' motivations and potentially highlight universal areas common to all library settings possibly fostering collaborative efforts to introduce improvement.

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