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A Tool for Evaluating Youth Engagement in an Informal STEM Setting: The WGG Observation Protocol

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A Tool for Evaluating Youth Engagement in an Informal STEM Setting: The WGG Observation Protocol

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Abstract: This paper discusses findings from the use of the Wise Guys and Gals (WGG) *Observation of WGG Youth Protocol* in a blended learning environment. The protocol was used to assess youth engagement when completing blended engineering design challenges at two Boys and Girls Clubs. WGG is a project funded through a grant from the National Science Foundation and which brings blended learning design challenges to middle school aged learners in informal STEM (science, technology, engineering, and mathematics) settings. This paper explores the feasibility of using the observation protocol to collect data about youth engagement, and the potential use of the protocol in other informal STEM settings.

Introduction

The purpose of this paper is to discuss findings from part of a program evaluation of the Wise Guys and Gals (WGG) project and its use of an observation protocol to assess engagement within the WGG program. The tool, *WGG Observation Protocol,* was implemented in two Boys and Girls Clubs (Site 1 and Site 2) during their implementation of two different blended engineering design project activities (Shark Tank and Designed for Sound) as part of their participation in the WISE Guys and Gals (WGG) program. The WGG program is a project that was funded through a grant from the National Science Foundation (Award Number DRL 1422436) and which brings blended learning design challenges to middle school aged learners in informal STEM (science, technology, engineering, and mathematics) settings. Specifically, this paper explores the a) feasibility of protocol implementation, and b) data generated about youth engagement through use of the protocol.

WGG Program

Today, afterschool programs provide youth access to STEM learning in environments that are more flexible and student-centered than traditional classrooms (National Research Council, 2015, Noam, G. G., & Shah, A., 2013). Robust afterschool STEM programs may build essential knowledge and skills while positively affecting attitudes toward STEM fields and careers (Allen, P. J., Noam, G. G., Little, T. D., Fukuda, E., Change, R., Gorrall,

B. K., & Waggenspack, L., 2016, Afterschool Alliance, 2019, 2012). There are, however, challenges that are indicative of an afterschool setting. First, instructional staff may not possess expertise in STEM or may not have formal STEM education training. Additionally, staff in afterschool settings can be transient, with a high rate of turnover. Due to these factors, the importance of access to a sustainable training model with easy-to-use tools is imperative to ensure the successful implementation of STEM programming.

The WGG program is a curriculum development project that engages middle school youth at Boys and Girls Clubs in 15 engineering-based activities through a blended learning model, containing both virtual and hands-on design experiences. WGG goals include increasing learner STEM engagement, knowledge and skills, engineering thinking, and awareness of STEM careers. While each Club has a different implementation model that fits the culture of the Club, at all Clubs WGG facilitators support learners through the implementation of various blended engineering design activities. Therefore, a key component of the WGG program is virtual training for staff that includes facilitator guides with detailed instructional information, short videos that showcase objectives, recommendations for preparing materials, and helpful tips, and technical support guides and videos. Collectively, the youth and staff modules provide a robust foundation for successful implementation, particularly for non-STEM instructional staff.

The recommended sequence for implementing the 15 activities developed for WGG is based on a scaffolded approach; each activity stands alone, yet the STEM concepts and skill builders are progressively more complex. Two examples of activities that were implemented during the WGG program are *Designed for Sound* and *Shark Tank*. *Designed for Sound* is an interdisciplinary activity, incorporating elements of science, technology and engineering. The youth build their scientific knowledge about permanent and electromagnets through the virtual learning module, then design and build a speaker that connects to a smart device. Throughout each activity, emphasis is placed on the constructs of the engineering design process: Specifications and Constraints, Knowledge Development, Ideate Solutions, Testing and Evaluations, Reflection and Redesign. While it is recommended that *Designed for Sound* be implemented earlier in the schedule, *Shark Tank* is the last. In this activity, youth are challenged to design and pitch a new WGG engineering design activity. This requires prior knowledge of the engineering design process, which youth should have developed during the course of the program.

Observation Protocol

External evaluation provided critical feedback to the project team and drove the subsequent refinement of the initial program design to determine if the WGG program was achieving its goals of increased STEM engagement, knowledge and skills, engineering thinking, and increased awareness of STEM careers. Additionally, the Project Team considered providing a simple formative assessment tool to be used by Club staff which was developed considering the methodology of Burghardt (n.d.). While there are many vetted assessment tools for classrooms, they are not appropriate for informal learning environments. In addition, many tools are designed for those who are trained observers or are in the form of surveys to be completed by youth. There is a need for high-quality assessment tools that are simple to use in the fast-paced, transient afterschool/informal STEM learning environment. The *WGG Observation Protocol* was developed for staff with little or no formal experience in assessment, requiring just 15 minutes of their time without interruption of youth engaged in activities. The tool provides insight on learner engagement and behavioral patterns.

The protocol was used at two different sites for two different activities (*Shark Tank* at Site 1, and *Designed for Sound* at Site 2). Initial use involved a non-STEM expert well versed in educational psychology and pedagogy who observed both activities and contacted facilitators to identify when activities would occur. Although the protocol is intended for use by untrained users, it was determined that an educational expert would be able to provide insight into protocol development in regards to the simplicity of implementation and its ability to get at youth engagement in an informal STEM setting. The observer then observed select days during implementation of each activity. Observations consisted of settling in, observing overall for approximately 10 minutes, then completing the protocol over the course of 5 minutes. At this point, the protocol was put aside. In general, the observer would leave at this point. However, for both sites, an observer stayed for the entirety of the session to get a sense of the alignment between the protocol results and in person observation. Following, findings document protocol results and site observations.

Findings

Shark Tank

Site 1 implemented *Shark Tank* over the course of 4 days. Children participated in reviewing knowledge skill builders (KSBs) and ideating solutions on Day 1, building prototypes, testing designs, and brainstorming about their pitches on Day 2, testing designs, finalizing prototypes and pitches, videoing and reviewing group pitches on Day 3, and in reflecting on Day 4. Site 1 observations took place on Day 2 and Day 3.

Day 2. Site 1 learners and the facilitator were gathered in the game room upon arrival. There were 7 children (5 girls and 2 boys) in the game room in various locations. Two learners were working at a bar table with two stools ideating various solutions. Two were on the floor discussing the design they had ideated, and one was building a prototype at the desk where the facilitator was sitting. As the child built, she engaged the facilitator in a discussion about her process and the strengths and challenges of her design. Two boys were watching a basketball game on one of the game room TVs and were not participating. However, the facilitator noted that they had participated on Day 1, but had chosen not to participate on Day 2 because they were not pleased with the learner feedback they received about the design they had ideated. The facilitator believed the boys would choose to come back to the project the next day after processing the previous day's feedback.

Day 2 *Shark Tank* work took place entirely in the Club game room. The game room, approximately the size of a basketball court, is a carpeted room with windows on all sides. In the game room, learners have access to snack machines, large (e.g., foosball, air hockey) and small (e.g., board games) electronic and non-electronic games, musical instruments (e.g., piano, guitar), and viewing technologies (e.g., two flat screen TVs). Seating options are informal (e.g., sofas, bar tables and stools, and the floor) with the exception of one large desk and chair where the facilitator is sitting. Despite all these items, and the size of the room which provides much space for walking and running, five of the children were actively engaged in *Shark Tank* upon arrival.

The Site 1 *Shark Tank* facilitator was not the usual Site 1 WGG facilitator. This exemplifies the ever changing nature of the facilitator role. Although the usual facilitator, a STEM expert, was not present, the Club needed to maintain its activity schedule and another facilitator was brought in to lead activities. The *Shark Tank* facilitator had been involved in WGG since its inception, although not always as a facilitator. While the *Shark Tank* facilitator had been involved in WGG since the beginning of the WGG project, she adamantly stated that she was not a STEM person and wasn't sure about many of the concepts. In fact, the *Shark Tank* facilitator acted as the children's guide throughout the activity. Children came to the facilitator with questions and to show her their work. The facilitator never directly commented on the STEM content. Rather, the facilitator responded with questions about the children's work (e.g., Do you think that would work? How would someone be able to use that? Do you think that is clear?), and prompts for further thinking (e.g., Why don't you look online to see what's already been done?). At no point did the facilitator request a child's participation or prompt a child to move to a particular part of *Shark Tank*. The activity was self-guided by the children who worked through the process at their own pace and based on their own interest. In fact, the facilitator noted that basketball started at the same time as *Shark Tank*, and that the children had chosen to participate in *Shark Tank* over basketball.

The *WGG Observation Protocol* was implemented approximately 10 minutes after arrival, and based on the performance of the two groups and individual child. The two children who were watching basketball were not considered as part of the observational protocol as they had opted out of participating in *Shark Tank* that day. All groups and the child working individually were rated as 3 (most or all learners demonstrate, but it may be infrequent or at a superficial level) on a 1 (no evidence of behavior) to 4 (most or all students demonstrate and do so consistently throughout the session) scale for the following areas.

- Youth are on task and not distracted.
- Youth are engaged and interested in the activity.
- Youth are paying attention.
- Youth are following directions.
- Youth contribute to team discussions.
- Youth conversations are related to the task.
- Youth persevere when encountering challenges or mistakes.
- Youth ask questions related to activity procedures.
- Youth verbalize connections between their lives or observations.

One behavior that was not observed by all youth, was their expression of their engagement or enjoyment verbally without prompting. However, the child working individually did tell the facilitator that she liked doing

particular parts of the build. It is also possible, the other two groups made mention of this. However, due to the size of the room, not all conversations could be heard while navigating the different experiences. Additionally, one item that was not applicable was the youth responding to questions in WISEngineering as learners did not work on tablets or on computers on Day 2.

Day 3. Learners were involved in finalizing their prototypes and pitches, and filming and reviewing their pitches on Day 3. Learners were already videoing their pitches upon arrival. *Shark Tank* implementation was taking place in 3 different locations. Learners finalizing prototypes and pitches were in the game room. Learners practicing and/or videoing pitches were doing so in the computer room and the hallway between the computer room and game room. Since learners were in different locations, and Day 2 observations focused on prototype development and testing, and pitch development and testing, Day 3 observations focused on pitch implementation and videoing, and learner pitch feedback.

The *WGG Observation Protocol* was again implemented approximately 10 minutes after arrival. Seven learners participated in Shark Tank on Day 3, as this time the two boys that had opted out on Day 2 chose to continue working with their prototype and on their pitch on Day 3. All groups videoing their pitches were rated as 4 (most or all students demonstrate and do so consistently throughout the session) on a 1 (no evidence of behavior) to 4 (most or all students demonstrate and do so consistently throughout the session) scale for the following areas.

- Youth are on task and not distracted.
- Youth are engaged and interested in the activity.
- Youth are paying attention.
- Youth are following directions.
- Youth contribute to team discussions.
- Youth conversations are related to the task.
- Youth persevere when encountering challenges or mistakes.
- Youth ask questions related to activity procedures.
- Youth verbalize connections between their lives or observations.

Again, one item that was not applicable was the youth responding to questions in WISEngineering. Learners were not working on tablets or on computers on Day 3. Also, one behavior that again was not observed by all youth, was their expression of their engagement or enjoyment verbally without prompting. However, on Day 3 all children were engaged for longer periods of time before running and/or chasing each other around the room, and/or bursting into bouts of signing and laughter, behavioral patterns that appeared to occur at points of duress when an issue wasn't necessarily resolved by a group learner conversation and/or a conversation with the facilitator.

Site 1 Protocol Implementation

Interestingly, during the course of the 15 minute observation while the protocol was used to guide the observation, children did jump up and run around the room periodically. They sometimes jumped up and chased each other around the room, started singing, and/or ran to the bathroom. However, they always came back to the task, and it appeared that these pieces occurred at points of duress when an issue wasn't necessarily resolved by a group conversation and/or a conversation with the facilitator. These behaviors that would normally be considered off task, appeared to support the learners in both processing the challenge and moving past the stress and/or tension they were experiencing in not yet determining the next step they would take with the various challenges they faced. This became evident as the observer looked for evidence of the various behaviors indicated in the protocol.

Additionally, use of the protocol revealed certain challenges. The protocol did not have an "N/A (not applicable)" option. However, indicating a "0 (no evidence of the behavior)" was significantly different than noting that the behavior was not applicable, as for the item "Youth respond to questions in WISEngineering." This piece was later revised on the protocol. Other considerations include room sizing, which does not always allow for observation of certain conversational items such as "Youth express their engagement or enjoyment verbally without prompting (e.g., "this is fun"), and room location. All groups must be present in the same space in order to be observed. Moreover, groups were involved in different parts of the Design Cycle. As groups were roughly equally engaged, this did not present a challenge in completing the protocol. However, it is possible that when groups are engaged in different steps of an activity, that groups at one step may be more involved than at other steps. Potential next steps might include focusing on one component of the Design Cycle and monitoring each group as they engage

in this part of the Design Cycle, and then comparing the results of the various groups. This should be further considered and addressed as protocol use continues.

Use of the protocol also revealed the advantages of such a tool. In trying to identify a rating for all groups, rather than individual groups, behavioral patterns became more salient. For example, when the children were problem solving, they used physical activities like running and/or chasing each other around the room to destress and/or process information. Rather than getting off track, these behaviors that would normally be deemed disruptive and/or off task actually appeared to support the children in furthering their next steps. Additionally, the protocol was very doable, in that it is easy to complete and the items overall were relevant to all children.

Designed for Sound

Site 2 implemented *Designed for Sound*. The activity, intended for completion in one day, was held in the Club computer lab. The lab consisted of computer cubicles along two walls and a large conference room table surrounded by chairs in the middle of the room. Just beyond the table was a large desk used by the facilitator and her assistant, which had *Designed for Sound* supplies. The program at Site 2 represented a more formal educational implementation model. All children participating in the WGG activity came into the room and sat at cubicles. They waited for the facilitator to lead them step by step through the process. The project was not self-paced and the learners were not permitted to move forward unless all learners were ready to move forward. In fact, the facilitator intention was to complete the *Designed for Sound* activity moving through the online portion before shifting to the build. However, due to technical issues that many learners faced, this goal was not realized on the day of the observation. Rather learners started with the online portion, where many were faced with system issues (e.g., slow wifi and connectivity issues). They then shifted to a whole group model where the facilitator used a smartphone to show learners on an individual basis select information from the facilitator videos, whereupon each child was instructed step by step to build a speaker.

As with Site 1, the *WGG Observation Protocol* was implemented approximately 10 minutes after arrival. Ten learners (3 female, and 7 male) participated and were being guided through logging on and getting into the WGG system. While 3 learners were able to log in, 7 were not. Learners were moving through the activity as one large group, and so tension and frustration was exhibited by all learners. All learners were rated as a 1 (no evidence of behavior) on a 4-point scale from 1 (no evidence of behavior) to 4 (most or all students demonstrate and do so consistently throughout the session) scale for the following areas.

- Youth are on task and not distracted.
- Youth are engaged and interested in the activity.
- Youth are paying attention.
- Youth respond to questions in WISEngineering
- Youth conversations are related to the task.
- Youth express their engagement or enjoyment verbally without prompting (e.g. “this is fun”)
- Youth persevere when encountering challenges or mistakes.
- Youth verbalize connections between their lives or observations.

All learners were rated as a 3 (most or all students demonstrate, but it may be infrequent or at a superficial level) on a 4-point scale from 1 (no evidence of behavior) to 4 (most or all students demonstrate and do so consistently throughout the session) scale for the following areas.

- Youth are following directions.
- Youth contribute to team discussions.
- Youth ask questions related to activity procedures.

Learners appeared to want to participate in the activity. This was determined by the observation that learners were largely following the facilitator’s directions, helping each other navigate system issues, and asking questions about how to log on and navigate the system, as well as sharing tips for dealing with the technical issues that arose. However, without individualizing the pacing and system navigation, learners who were able to navigate the system did not move on until other learners were ready to move on too.

After completing the protocol, the observation continued for the entirety of the session. The facilitator wanting to expose the learners to the KSBs and the activity eventually brought all the learners to the conference

table, and one by one showed pieces from the facilitator videos on a smartphone. During this time, support was brought in to help the facilitator manage both learner behaviors interpreted as disruptive and the computer issues faced (e.g., slow speeds and lack of system connectivity). However, the facilitator was already engaging learners in building the device shifting from a process to outcomes focused implementation approach (e.g., do this, next do this, and so on).

Site 2 Protocol Implementation

Site 2 protocol implementation was more direct. Learners were engaged in the same steps and so the consideration of the elements was very straight forward. Interestingly, learners "off task" behaviors again occurred at points of frustration or where problems needed to be solved. However, because learners could not self-pace, these learners did not move past the issues encountered with the technology to move further into the Design Cycle.

The Site 2 facilitator was new to WGG. The facilitator exhibited similar behaviors to those observed in WGG at the start of the project. That is when faced with a whole group classroom management model, the facilitator found it particularly challenging to navigate learner questions, and technology issues. The facilitator's auxiliary plan was to shift away from the technology to an outcomes focused approach (e.g., build the speaker).

Discussion

Protocol

Use of the protocol revealed that protocol implementation is quite doable in that it is quick to fill out, and the items appear on target. However, recommendations include having someone other than the facilitator carefully observe the activities and complete the protocol so that key behavioral patterns (e.g., patterns that indicate destressing, and/or problem solving) may be more readily identifiable, and activity guidance is not interrupted in order to complete documentation.

Additionally, data should be looked at for what it provides, rather than what is missing. For example, at both sites non-STEM facilitators led learners through activities. This is quite common for the culture of a Club. Facilitators are not required to have a STEM background, and are not required to be teachers. Therefore, findings may be considered and interpreted by those with more expertise to consider where the experience may be further developed. For example, at Site 1, while completing the Shark Tank activity, it became evident that the facilitator was not having the learners evaluate each other's designs. This may be something that could easily be addressed in the online Professional Development.

Club Culture

The Boys and Girls Clubs have a number of Clubs that each have their own unique culture. For example, Site 1 had a drop in program model whereby learners could come to and leave the project at will. In fact, learners freely participated, although they had access to other programming options (e.g., basketball) and a variety of entertainment technologies and tools (e.g., TV, musical instruments, etc.). At Site 2, the Club had a more formal classroom setting model where the majority of WGG learners were present at the onset of the activity and were led by the facilitator through each step of the process. Children were stationed at computer cubicles and instructed to log on, and go to Step 1. The process and facilitation that occurred were very different.

Facilitation

Facilitator buy-in, background, and comfort level with STEM is not consistent across Clubs. WGG Club facilitators at some Clubs were stable throughout the course of the project, while at other Clubs facilitators often changed over the course of the project, had assistants lead activities, and/or had replacements take over while away and/or on leave. Additionally, not all facilitators had STEM backgrounds, and/or had expertise in education/teaching, management, and/or technology. These skills are necessary to optimize the implementation and support of the WGG project and WGG learners. Interestingly, at Site 1, although the facilitator was not a STEM expert, and not necessarily comfortable facilitating STEM activities, the facilitator's learner centered approach and

facilitation provided the freedom children needed to self-pace and design freely. In contrast, at Site 2, the whole group approach did not appear conducive to learner engagement. When problems were encountered, all learners had to wait for problems to be solved which appeared to frustrate learners who were prepared to move forward and not encountering similar issues.

Approach: Process versus Outcome

Using the protocol highlighted the importance of the engineering design process and a culture of facilitation that stresses process over outcome. At Site 1 where the facilitator provided a setting where learners worked with the tools and materials provided by the WGG team at their own pace and with minimal intervention, learners were able to focus on the task, think deeply about their various challenges, and be guided by their own interests and findings. Certainly, consideration must be given to how facilitators may be further encouraged to and supported through guiding learners in evaluating each other's work and reflecting on the Design Process. However, overall this more child directed form of implementation appeared to support engagement. If one were to look at the outcome for the *Shark Tank* activity (e.g., the videos) one might conclude that learners were not engaged in the design process. However, the protocol brought to light the level of engagement, the behaviors that supported resilience in the face of challenges that arose, and the learning and development that took place as children took part in the various elements of the Design Cycle. In fact, at Site 2, these same behaviors were exhibited when learners were faced with challenges. However, as students were not in a setting where they were self-pacing, they could not move forward unless all learners moved forward. Therefore, resolution was never reached. In fact, the resolution taken was to shift from the process to the activity outcome (e.g., an actual speaker). Learners were directed through the speaker building and did not actually participate in the various parts of the Design Cycle.

Limitations

While the use of the tool provided insight into its feasibility of the protocol implementation, and protocol results were explored by the additional site observation data gathered after protocol completion, further use is recommended for protocol optimization and understanding. Next steps should include having Club personnel use the protocol and provide feedback, perhaps assessing learner engagement via another survey (e.g., learner flow) to compare results, and finally revising directions so that implementers have more insight into how protocol implementation might vary and/or could be optimized (e.g., focus on one Design Cycle component).

Educational Implications

Although the protocol was implemented in a Boys and Girls Club setting, informal learning environments are vast and growing. The National Research Council (2009) brought structure to the field by identifying three informal settings: everyday settings, designed settings, and programs. Each is characterized by the degree of choice a learner has in shaping the experience. Everyday settings include internet searches, TV, books, and family discussions. Designed settings (museums, libraries, nature centers, etc.) are structured environments where learners determine the level of interaction and engagement. Finally, program-based settings (after-school, summer programs, clubs, etc.) utilize a formal curriculum to build specific content knowledge and skills, and learners choose to participate by area of interest. Despite the great variation in informal learning environments, they share basic characteristics that promote learning and engagement (National Research Council, 2009; National Research Council, 2010).

It is these shared characteristics to which we would like to draw your attention. We maintain that the designed and program settings are settings that may benefit from utilization of the WGG assessment tool. In using the tool, we determined that it brought attention to elements of learner behavior that may previously have been labeled as "off task" and "disengaged." Since the protocol draws user attention to variations in learner behaviors across various constructs, reviewers were able to identify patterns in between traditional learning points. For example, learners may have been exhibiting traditionally "on task" behaviors while talking about a problem. However, when they reached a point of conflict, or struggle, they then often exhibited behaviors that have traditionally been viewed as "off task," such as running around the room, singing, leaving the group. It became

evident through use of the protocol that these learners returned to the original problem solving setting with new ideas and insights that appear to have been generated during these "off task" moments. Therefore, this protocol may be useful in attending to aspects of learning and development that occur in non-traditional ways, and drawing user attention to these key behaviors.

In sum, the protocol appears feasible for use in informal STEM settings. However, further honing to support assessment implementation is recommended. The assessment may be valuable in drawing facilitator attention to learner behaviors that support engagement and support facilitator understanding and interpretation of the observed behaviors while in the informal STEM setting. It should be noted that the protocol was only implemented in Boys and Girls Club settings, and implementing the protocol in other informal environments would inform the learning community of areas where the protocol is most valuable and needs revision. Additionally, it would be beneficial to learn more about how the findings are used in formative ways by each informal STEM setting.

Conclusion

In conclusion, the *WGG Observation Protocol* is a promising tool for assessing youth engagement and formatively addressing Project needs based on findings. The tool enabled us to consider how learner behaviors might actually be productive rather than off task, and to be aware of learner behaviors that support engagement. The tool can support Clubs, and other informal STEM settings, in formatively assessing youth engagement and being responsive to findings, while also providing administrators with snapshot summative information. While further use is recommended so that we can learn more about how the protocol is supportive in other informal STEM settings, and how the instructions may be refined, findings are encouraging and indicate the tool may be valuable for use beyond Boys and Girls Clubs in other informal STEM settings.

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